

ROLE OF MAGENISUM, WATER CONTENT AND FRETILIZERS ON SOME ELEMENTS AVAILABILITY IN CLAYEY SOIL

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ABSTRACT

A Laboratory experiment carried out during 2010/2011 at Fac. Agric., Mansoura Univ., to study some nutrients availability in clayey soil as affected by magnesium, water content and mineral fertilizers. The used experimental design was split-split design with three replicated.

- Statistical analysis of the obtained results reveal that the content of all Av. nutrients increased significantly in the upper soil section (0-5 cm) with Mg addition, 150% field capacity and fertilizer treatments
- Data reveal that the content of all Av. nutrients increased significantly in the lower soil section (5-10 cm) with Mg addition, 150% of field capacity and fertilizer treatments but the content of Av. Ammonium increased insignificantly with adding of Mg.
- Data reveal that the increasing percent of all Av. nutrients concentration caused by magnesium and water content under different fertilizer condition. It noticed under different mineral fertilizer treatments that treatment with Mg1W2 gave the highest increasing percentage of all Av. nutrients as compared to control (Mg0W1) in both section.
- Data reveal that, the fertilizer treatment F3 application raising the content of Av. K in the first section of soil column. It also shows that the best fertilizer treatments for increase the content of Av. NH_4^+ and NO_3^- in the first section of soil column were F2. Also with adding of treatment of F5, a highly increase of Av. P content in the first section of soil column high increased in both section.
- It can be concluded that the highest mean values of the content of all Av. nutrients obtained from Mg1W2 among all treatment.

INTRODUCTION

Large areas in different governorates were suffering from decreasing magnesium content. There is a continuous depletion of magnesium from Egyptian soils and adding magnesium fertilizers would help in sustaining the soil fertility, prevent its deterioration in soils and increase yields without harming the environment. El-Fouly, *et al.*, (2010).

Magnesium (Mg) is the most abundant cation occupying the exchange sites of the soil colloids, both inorganic and organic. These found in soil solution and adsorbed on the clay and organic matter surfaces. Soils usually contain less Mg than Ca because Mg^{2+} ions not adsorbed, as strongly by clay and organic matter as Ca^{2+} ions on the other hand, Mg^{2+} ions are more susceptible to leaching than Ca^{2+} ions. Soil magnesium is a moderately leachable nutrient as compared to calcium, and greater amounts often found

in the subsoil than in the upper parts of the soil profile, especially in older and highly weathered soils. *Senthurpandian et al., (2009)*.

In Egypt, chemical fertilizers used heavily to maintain to the soil fertility and to ensure crop production. *Badiane, et al. (1994)* reported that Egypt's consumption of fertilizers is more than 10 times as much of all nutrients per hectare as dose the average for the whole world.

Water content is one of the most variable characteristics of soil. The soil acts as a reservoir for water, making it available for plants as it needed. Soil water is very important to the entire soil system, not only because it is necessary for plant growth, but because the nutrients required for plant growth are also present in the soil solution. Most of the important soil reactions (weathering, cation exchange, organic matter decomposition, fertilization) take place in the context of the soil solution. Thus, it is evident that the moisture status of a soil is a key property.

The interaction of water with soil colloids plays a critical role in all areas of soil science, and numerous studies have shown that exchangeable cations significantly influence soil–water relations. *Dontsova, et al., (2004)*. Therefore, the present study aimed to study some nutrients availability as affected by magnesium, water content and mineral fertilizers in clayey soil.

MATERIALS AND METHODS

An experiment carried out during 2010/2011 at the Laboratory experiment in Fac. Agric., Mansoura Univ., to study the nutrients availability in clayey soil as affected by magnesium, water content and mineral fertilizers. The used experimental design was split-split design with three replicated. The experiment conducted out in the incubation experiment using soil column using PVC cylinder with diameter 10cm and length 26cm, the soil put and compressed in a plastic bag then put in a PVC cylinder. Soil column have 2.28 kg of clayey soil arranged in the plastic bags and this weight give us height of 20cm. Combination effect of mineral fertilizer with magnesium:

Five treatments of mineral fertilizers as following:

- Control (without mineral fertilizers) (F1).
- Nitrogen (F2).
- Nitrogen + potassium (F3).
- Nitrogen + phosphorus (F4).
- Nitrogen + potassium + phosphorus (F5).

Two treatments of magnesium fertilizers as following:

- Without magnesium (Mg0).
- With magnesium (Mg1).

The moisture adjusted at two levels:

- Rate of 100% of field capacity (W1)
- Rate of 150% of field capacity (W2).

The Fertilizer used:

N Fertilizer: Ammonium Nitrate NH_4NO_3 (33.5%N) was used as a source of N. Each N treatment, were received 0.455 g Ammonium Nitrate column⁻¹

which equal (0.2g Ammonium Nitrate kg⁻¹ soil, and 153 kg Ammonium Nitrate fed⁻¹).

P Fertilizer: Calcium super phosphate Ca (H₂PO₄)₂ + CaSO₄ (15.5% P₂O₅) was used as a source of P. Each P treatments received 0.343g super phosphate column⁻¹, which equal (0.151 g super phosphate kg⁻¹ soil, and 150 kg super phosphate fed⁻¹).

K Fertilizer: Potassium sulfate K₂SO₄ (50% K₂O) was used as a source of K. Each K treatments received 0.2275g potassium sulfate column⁻¹, which equal (0.1 g potassium sulfate kg⁻¹ soil, and 100 kg potassium sulfate fed⁻¹).

Mg Fertilizer: Magnesium sulfate MgSO₄·7H₂O was used as a source of Mg. Each Mg treatments received 0.3731g magnesium sulfate column⁻¹, which equal (0.164 g magnesium sulfate kg⁻¹ soil, and 80 kg magnesium sulfate fed⁻¹).

Data in Table 1 show some physical and chemical properties of the experimental soil. Soil samples were sieved and routine analysis in the beginning of the experiment done according to *Dewis and Freitas (1970)*, *Hesse (1971)* and *Piper (1950)*. Soil samples were taken after 20 days from the beginning of the experiment. All columns separated to 2-section graduate from the top to down with a height of 5cm to be analyses.

Table 1: Some physical and chemical properties of the experiment soil.

pH (1:2.5)	E.C ds.m ⁻¹ (soil paste)	Ions mg kg ⁻¹ soil							
		Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺	CO ₃ ⁻²	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁻²
8.2	0.27	0.33	0.63	0.34	0.07	-	0.2	0.38	0.79
Mechanical analysis %				O.M %	CaCO ₃ %	Available (ppm)			
sand	Silt	Clay	Texture			N	P	K	
36.58	29.9	33.52	clay loam	0.5	1.3	66.15	15	210	

All data statistically analyses according to the technique of analysis of variance (ANOVA) and the least significant differences between the treatment means as published by *Gomez and Gomez (1984)*.

RESULTS AND DISCUSSION

1. Available nutrients (mg kg⁻¹) in the upper soil section (0-5 cm):-

a. Single effect

As shown in Table (2) concerning Mg treatments, it found that with Mg addition the content of all Av. nutrients increased significantly with Mg addition. The increasing percentages were 45.16, 30.2, 10.43, 14.71 and 18.66% as compared with control for Av. Mg, K, NH₄⁺, NO₃⁻ and P respectively.

Concerning water content treatments, it found that all Av. nutrients increased significantly with 150% of field capacity. The increasing percentages of nutrients availability were as follow P > K > Mg > NO₃⁻ > NH₄⁺.

Concerning fertilizer treatments, it found that with fertilizer treatments additions the content of all Av. nutrients in the first section of soil column increased significantly. The increasing percentages of Av. magnesium were (42.25, 50.40, 48.76 and 41.57%), Av. potassium was (21.35, 52.25, 8.99 and

51.13%), Av. ammonium was (10.89, 5.72, 9.57 and 7.66%), Av. nitrate was (25.52, 20.65, 23.70 and 21.28%) and Av. phosphorus was 11.23, 11.50, 21.86 and 36.68% as compared with control (F1).

Table 2: Effect of Mg, water content and fertilizer treatments on available nutrients in the upper section of the soil column (0-5 cm).

Treatments	K	NH ₄	NO ₃	P	Mg
Mg0	191.10 b	42.94 b	40.05 b	26.90 b	632.16 b
Mg1	248.82 a	47.42 a	45.94 a	31.92 a	917.64 a
F test	**	**	*	*	**
LSD at 5%	3.493	0.047	3.654	2.275	1.789
W1	197.73 b	44.21 b	41.46 b	25.78 b	715.20 b
W2	242.19 a	46.16 a	44.53 a	33.04 a	834.60 a
F test	**	*	**	**	**
LSD at 5%	6.646	1.537	1.258	0.448	0.385
F1	173.55 d	42.32 d	36.37 c	25.30 d	567.30 e
F2	210.60 b	46.93 a	45.65 a	28.14 c	807.00 c
F3	264.23 a	44.74 c	43.88 b	28.21 c	853.20 a
F4	189.15 c	46.37 a b	44.99 a b	30.83 b	843.90 b
F5	262.28 a	45.56 b c	44.11 b	34.58 a	803.10 d
F test	**	**	**	**	**
LSD at 5%	6.597	1.306	1.240	0.775	2.361

b. Interaction effect:-

Data in Fig (1) show the interaction effect of magnesium, water and fertilizer in the upper soil section (0-5 cm) it found that increased the percentage of potassium concentration as compared to F1. Under Mg0W1 were (2.78, 66.67, 16.67 and 63.89 %) and Mg1W2 were (33.90, 44.07, 5.08 and 35.59 %) so it is noticed from these percentages that treatment with F3 gave the highest increasing percentage of potassium compared to control (F1). Under Mg1W1 were (21.43, 57.14, 9.52 and 61.90%) and Mg0W2 were (22.50, 50, 10 and 55 %). It noticed from these percentages that the treatment with F5 gave the highest increasing percentage of potassium as compared to control.

Data in Fig (2) show the interaction effect of magnesium, water and fertilizer in the upper soil section (0-5 cm) it found that increased phosphorus concentration percentage as compared to F1. These increases were Mg0W1 (8.56, 12.60, 38.41 and 67.98 %), Mg0W2 (11.60, 6.61, 12.60 and 29.89%), Mg1W1 (3.21, 4.86, 7.66 and 23.88%) and Mg1W2 (19.85, 21.43, 33.10 and 34.94 %). It noticed from these percentages that the treatment with F5 gave the highest increasing percentage of phosphorus as compared to control.

Data in Fig (3) show the interaction effect of magnesium, water and fertilizer in the upper soil section (0-5 cm) it found that increased nitrate concentration percentage as compared to F1. These increases were Mg0W1 (32.32, 21.49, 35.47 and 30.41 %) and Mg0W2 (26.19, 20.37, 26.56 and 23.10%). It noticed from these percentages that treatment with F4 gave the highest increasing percentage of nitrate as compared to control. Under Mg1W1 (31.03, 27.93, 24.33, 27.38%) and Mg1W2 (15.60, 14.31, 12.45 and

8.30 %). It noticed from these percentages that treatment with F2 gave the highest increasing percentage of nitrate as compared to control.

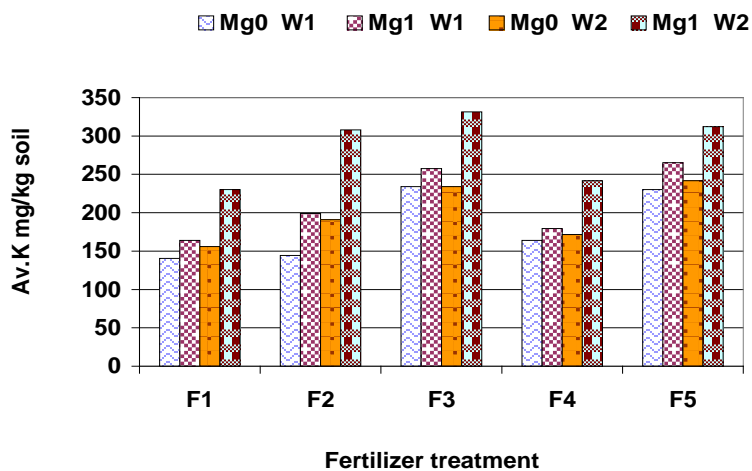


Fig (1): Effect of fertilizer treatments, Mg, and water content on Av. K in the upper 5 cm soil.

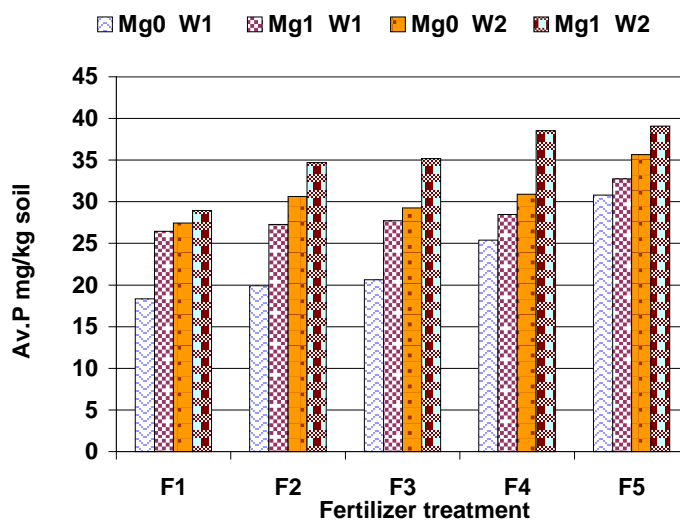


Fig (2): Effect of fertilizer treatments, Mg, and water content on Av. P in the upper 5 cm soil.

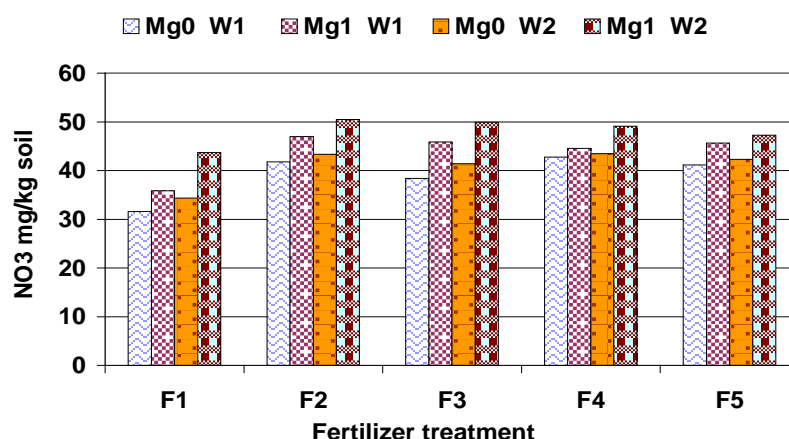


Fig (3): Effect of fertilizer treatments, Mg, and water content on NO₃ in the upper 5 cm soil.

Data in Fig (4) show the interaction effect of magnesium, water and fertilizer in the upper soil section (0-5 cm) it found that increased ammonium concentration percentage as compared to F1. These increases were Mg0W1 (9.50, 4.55, 12.60 and 8.14 %) and Mg0W2 (6.46, 1.23, 8.05and 4.05%). It noticed from these percentages that treatment with F4 gave the highest increasing percentage of ammonium as compared to control. Under Mg1W1 (11.88, 2.85, 6.30and 4.88%) and Mg1W2 (15.33, 13.84, 11.48 and 13.35 %). It noticed from these percentages that treatment with F2 gave the highest increasing percentage of ammonium as compared to control.

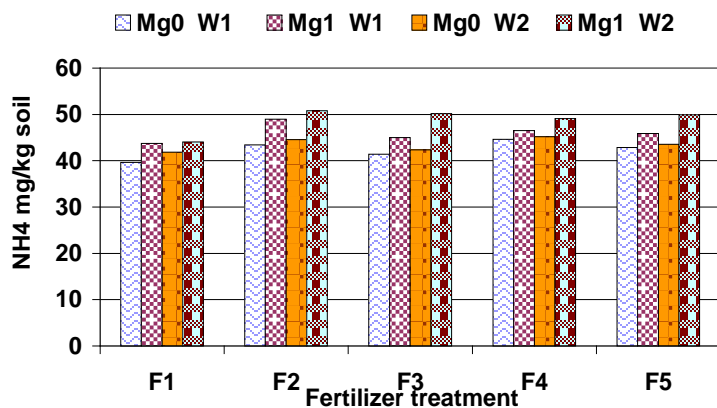


Fig (4): Effect of fertilizer treatments, Mg, and water content on NH₄ in the upper 5 cm soil.

Data in Fig (5) show the interaction effect of magnesium, water and fertilizer in the upper soil section (0-5 cm) it found that increased magnesium concentration percentage as compared to F1. These increases were Mg0W1 (52.79, 89.18, 119.02 and 9.22 %) and Mg0W2 (34.18, 24.89, 41.35 and 12.24 %). It noticed from these percentages that treatment with F4 gave the highest increasing percentage of magnesium as compared to control. Under Mg1W1 (30.74, 44.81, 28.33 and 62.04%) and Mg1W2 (54.20, 56.12, 36.71 and 61.19%). It noticed from these percentages that treatment with F5 gave the highest increasing percentage of magnesium as compared to control.

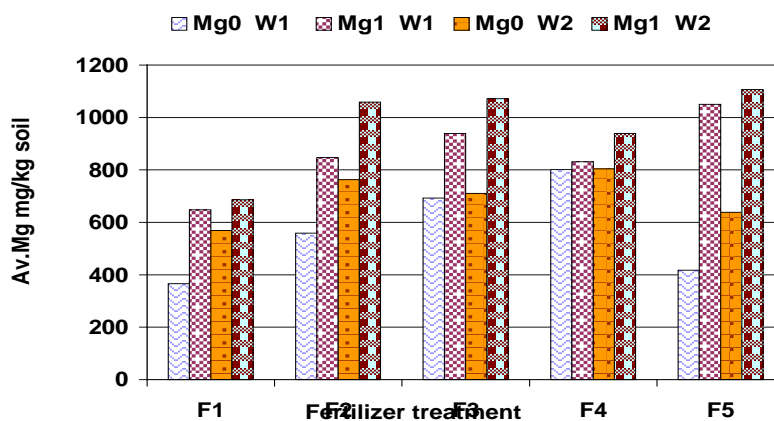


Fig (5): Effect of fertilizer treatments, Mg, and water content on Av. Mg in the upper 5 cm soil.

2. Available nutrients (mg kg⁻¹) in the lower soil section (5-10 cm):-
a. Single effect

Data listed in Table (3) illustrate that with Mg addition, the content of Av. Ammonium in the second section of soil column was increased but it was insignificantly, whereas the other Av. nutrients increased significantly with adding of Mg. The increasing percentage of nutrients availability were as follow Mg >P > NO₃⁻ > K>NH₄⁺ with Mg addition.

Concerning water content treatments, it found that all Av. nutrients increased significantly with 150% of field capacity. The increasing percentage were 11.19, 23.79, 2.61, 6.63 and 26.38% as compared with the control for Av. Mg, K, NH₄⁺, NO₃⁻ and P respectively

Concerning fertilizer treatments, it found that with fertilizer treatments additions the content of all Av. nutrients in the second section of soil column increased significantly. The increasing percentages of Av. magnesium were (86.79, 38.48, 20.42 and 60.11%), Av. potassium was (12.12, 32.12, 23.03 and 20%), Av. ammonium was (13.26, 5.87, 9.77 and 10.87%), Av. nitrate was (36.92, 31.06, 29.45 and 33%) and Av. phosphorus was (7.13, 22.99, 56.12 and 77.12%) as compared with control.

Table 3: Effect of Mg, water content and fertilizer treatments on available nutrients in the lower section of the soil column (5-10 cm).

Treatments	K	NH ₄	NO ₃	P	Mg
Mg1	181.74 b	40.01 a	45.14 b	21.22 b	597.36 b
Mg2	196.17 a	42.40 a	50.84 a	25.64 a	729.84 a
F test	**	NS.	**	**	**
LSD at 5%	4.844	--	0.519	0.843	4.7695
W1	168.87 b	40.67 b	46.45 b	20.70 b	628.44 b
W2	209.04 a	41.73 a	49.53 a	26.16 a	698.76 a
F test	**	**	**	**	**
LSD at 5%	2.254	0.327	1.531	0.928	1.924
F1	160.88 d	38.17 d	38.06 d	17.66 e	470.10 e
F2	180.38 c	43.23 a	52.11 a	18.92 d	878.10 a
F3	212.55 a	40.41 c	49.88 b c	21.72 c	651.00 c
F4	197.93 b	41.90 b	49.27 c	27.57 b	566.10 d
F5	193.05 b	42.32 a b	50.62 b	31.28 a	752.70 b
F test	**	**	**	**	**
LSD at 5%	7.536	1.322	0.982	0.869	2.573

b. Interaction effect:-

Data in Fig (6) show the interaction effect of magnesium, water and fertilizer in the lower soil section (5-10 cm) it found that increased the percentage of potassium concentration as compared to F1. Under Mg0W1 were (13.16,26.32,23.68 and 21.05%) , Mg0W2 were (25.64,41.03,30.77 and 28.21%) , Mg1W1 were (10.81,24.32,24.32 and 10.81%) and Mg1W2 were (1.96,35.29,15.69 and 19.61%) . It noticed from these percentages that treatment with F3 gave the highest increasing percentage of potassium as compared to control.

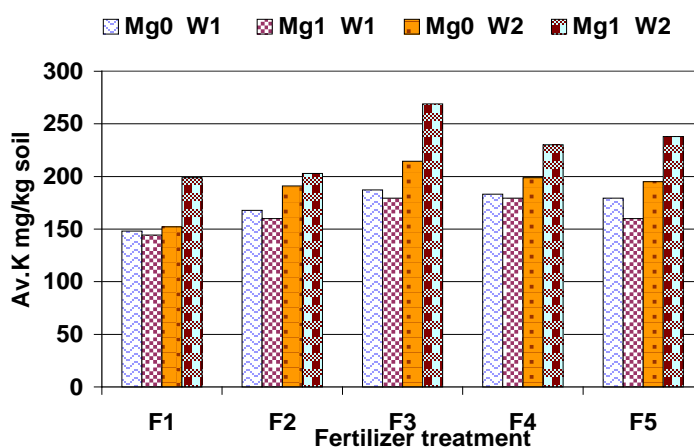


Fig (6): Effect of fertilizer treatments, Mg, and water content on Av. K in the lower 5-10 cm soil.

Data in Fig (7) show the interaction effect of magnesium, water and fertilizer in the lower soil section (5-10 cm) it found that increased phosphorus concentration percentage as compared to F1. These increases were Mg0W1 (0.75, 17.51, 36.13 and 46.56%) and Mg0W2 (6.33, 20.39, 75.23 and 89.65%), Mg1W1 (7.71, 19.09, 70.47 and 86.25%) and Mg1W2 (12.01, 31.93, 45.30 and 78.59%). It noticed from these percentages that treatment with F5 gave the highest increasing percentage of phosphorus compared to control.

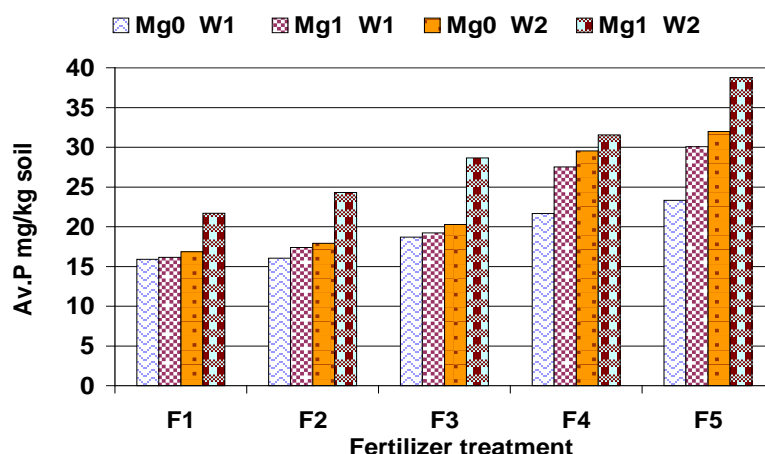


Fig (7): Effect of fertilizer treatments, Mg, and water content on Av. P in the lower 5-10 cm soil.

Data in Fig (8) show the interaction effect of magnesium, water and fertilizer in the lower soil section (5-10 cm) it found that increased nitrate concentration percentage as compared to F1. These increases were Mg0W1 (48.35, 34.40, 35 and 37.69%), Mg0W2 (43.05, 35.94, 35.96 and 42.71%) and Mg1W2 (28.86, 22.71, 20.22 and 21.13%). it noticed from these percentages that treatment with F2 gave the highest increasing percentage of nitrate as compared to control. Under Mg1W1 (27.35, 29.88, and 26.04 %). it noticed from these percentages that treatment with F3 gave the highest increasing percentage of nitrate as compared to control.

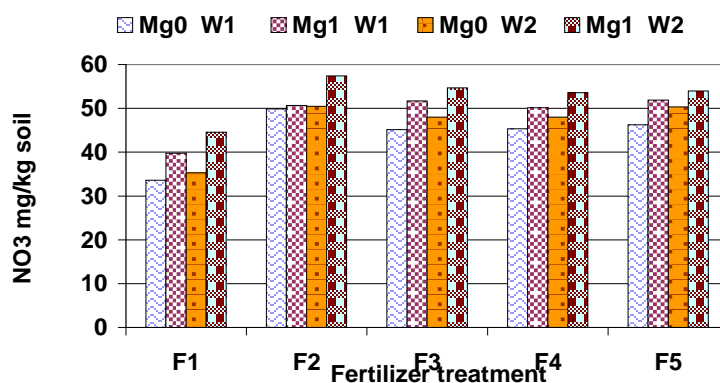


Fig (8): Effect of fertilizer treatments, Mg, and water content on NO₃ in the lower 5-10 cm soil.

Data in Fig (9) show the interaction effect of magnesium, water and fertilizer in the lower soil section (5-10 cm) it found that increased the percentage of ammonium concentration as compared to F1. These increases were Mg0W1 (14.92, 7.14, 12.84 and 11.63%), Mg0W2 (13.10, 6.88, 10.92 and 10.27%), Mg1W1 (13.57, 4.89, 9.25 and 10.29%) and Mg1W2 (11.63, 4.79, 6.48 and 11.37%). It noticed from these percentages that treatment with F2 gave the highest increasing percentage of ammonium as compared to control.

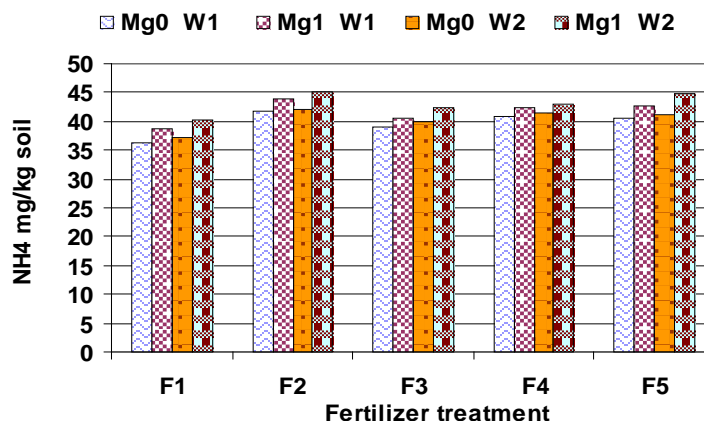


Fig (9): Effect of fertilizer treatments, Mg, and water content on NH₄ in the lower 5-10 cm soil.

Data in Fig (10) show the interaction effect of magnesium, water and fertilizer in the lower soil section (5-10 cm) it found that increased the percentage of magnesium concentration as compared to F1. These increases were Mg0W1 (102.25,43.09,37.30 and 64.63 %), Mg1W1 (86.06,44.50,20.78 and 60.88%), Mg0W2 (77.69,16.79,15.04 and 55.64%) and Mg1W2 were (84.82,49.11,13.17 and 60.27 %). It noticed from these percentages that treatment with F2 gave the highest increasing percentage of magnesium as compared to control.

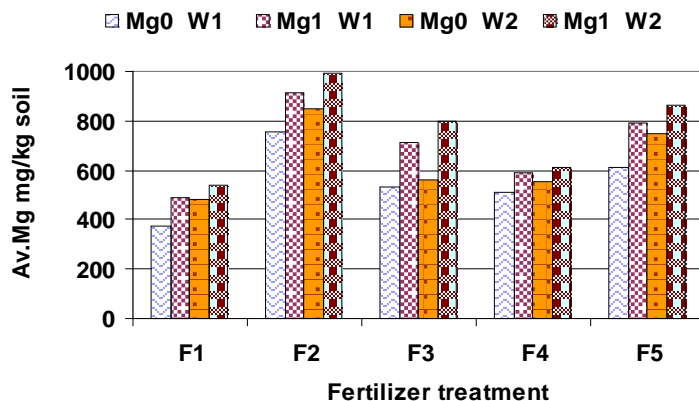


Fig (10): Effect of fertilizer treatments, Mg, and water content on Av. Mg in the lower 5-10 cm soil.

Data reveal that the content of all Av. nutrients increased with adding Mg, as mentioned by Fuad, *et al.*, (1972), Moustafa and Omran (2006) and Rasul, *et al.*, (2011). It reveals that the content of all Av. nutrients increased with 150% field capacity. As obtained by Zeng and Brown (2000) and Dontsova, *et al.*, (2005). In addition, Data reveal that treatment F3 gave the highest increasing percentage of potassium compared to control. As recorded by Jeganathan (1990) and Assimakopoulos, *et al.*, (1994).

Data reveal that treatment F5 gave the highest increasing percentage of phosphorus compared to control. As mentioned by Fageria (1983) and Lasa, *et al.*, (2000). It is also reveal that treatment F4 and F5 gave the highest increasing percentage of magnesium compared to control in the upper 0-5 cm soil. As recorded by Bell and Robson (1999).

Data reveal that treatment F2 gave the highest increasing percentage of magnesium compared to control in the lower 5-10 cm soil. As obtained by Moustafa and Omran (2006) and Jayaganesh *et al.*, (2011).

It can be concluded that the highest mean values of the content of all Av. nutrients obtained from Mg1W2 among all treatment.

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دور الماغنسيوم والمحتوى المائى والاسمده على صلاحية بعض العناصر فى الارض الطينية

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** معهد الأراضى والمياه والبيئة- مركز البحوث الزراعيه- الجيزه - مصر

اجريت تجربة تحضين معملية بمعمل قسم الاراضى بكلية الزراعة-جامعة المنصورة خلال موسم 2010-2011 باستخدام عمود التربه لدراسة مدى تأثير صلاحية العناصر بالماغنسيوم باضافه معدلين من الماغنسيوم (بدون-مع) واطافه معدلات من الاسمده المعدنيه واطافه الماء عند 100% من السعه الحقلية و150% من السعه الحقلية فى الارض الطينية وتم اخذ العينات بعد (20 يوم) وتم تقسيم عمود التربه الى قطاعين كل منهما 5 سم ، وفيما يلي عرض لمخلص النتائج المتحصل عليها:

- أوضحت النتائج زياده محتوى كل العناصر مع اضافة الماغنسيوم و150% من السعه الحقلية واطافه الاسمده فى الطبقة السطحية(0-5 سم).
- أظهرت النتائج زياده محتوى كل العناصر مع اضافة الماغنسيوم و150% من السعه الحقلية واطافه الاسمده فى الطبقة التحت سطحية(5-10 سم).
- تبين من النتائج أن مع اضافة الماغنسيوم والماء عند 150% من السعه الحقلية اعطى اعلى صلاحية للعناصر فى كلا من الطبقتين.
- اوضحت النتائج زياده محتوى عنصر البوتاسيوم مع اضافة سمادى النتروجين والبوتاسيوم معا وزياده محتوى الفوسفور مع اضافة اسمده النتروجين والبوتاسيوم والفوسفور معا وزياده محتوى النتروجين مع اضافة الاسمده النتروجينية وذلك فى كلا الطبقتين.

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