EFFECT OF MAGNETIC WATER AND PHOSPHORUS RATES ON SOME NUTRIENTS UPTAKE BY SUMMER SQUASH GROWN IN CALCAREOUS SOIL OF DUHOK GOVERNORATE

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Abstract:
This study was conducted at the college of Agriculture/ Duhok University during August-November 2009, to study the effect of magnetic water treatment and phosphorus fertilizer rates (P0= 0, P1= 90, P2 = 180, P3 = 270) kg P_2O_5 ha^{-1} and their interactions on some nutrient uptake by summer squash plant in addition to their effect on some chemical properties soil at (0-15 and 15-30 cm) depth. Mulla-Ahmed seeds were sown in ridges 0.5 m apart. Half of the treatments were irrigated with well water and the other half with the same water after magnetization. The results indicated that magnetic water significantly increased dry weight of plants and also had significant effect on uptake of nutrients by plant and soil nutrients and they were significantly higher at 0-15 cm. An interaction of P3 x MW gave best uptake values by plant for most nutrients, higher concentration of calcium, magnesium, total nitrogen and phosphorus in the soil.

***KEYWORDS*:** *magnetic water, P rates, nutrients concentration, summer squash.*

Introduction:

The effect of magnetic treatment on irrigation water has been studied by many investigators; the main effect was an increase in the number of crystallization centers and the change in the free gas content. Both effects improved the quality of irrigation water (Bogatin et al., 1999) which resulted in better nutrient uptake by plants, Davis and Rawls, (1996), and exerted a positive effect on nutrient mobility and availability (Hozayn and Abdul Qados, 2010).

In many agricultural soils the recovery of applied P by plants in a growing season is very low, because in the soil more than 80% of the P becomes immobile and unavailable for plant uptake due to adsorption and precipitation processes in the soil (Holford, 1997). Tisdale et al. (1993) reported that using P fertilizers, especially superphosphate, as a very common method of providing plant P requirement, is not very efficient in calcareous and alkaline soils, because under such conditions high amounts of P are turned into insoluble products and become unavailable to the plant, as only 20% of the fertilizer is soluble in the first year of use.

Taha et al., (1980), established that the uptake of phosphorus in calcareous soils is very low and does not significantly increase by raising the amount of phosphate fertilizers. Al-Kaabi (2006) reported that irrigation with magnetic water led to a significant increase in S, Zn, Fe, P and N concentrations in leaves, also improved all vegetative growth and root characteristics of orange plant. Maheshwari and Grewal, (2009), found that irrigating celery with magnetically treated water significantly increased Ca and P concentrations of celery shoots. Miraslav and Morse, (1998), also mentioned that magnetic water improve the effectiveness of phosphorus and the availability of nitrogen from the soil layers and increased the concentration of dissolved O_2 by 10% in irrigation water that have a positive effect on root respiration and growth.

Since there are little or no studies about the effect of magnetized water on phosphorus availability and nutrient uptake by squash plant, Therefore this study was selected to investigate whether there are any beneficial effects of magnetic water on phosphorus availability in calcareous soil of Kurdistan Region and also to study the response of squash plants to different phosphorus rates under magnetic treatments.

Materials and Methods:

The experiment was conducted at the Agricultural College/Dohuk University/Kurdistan Region/ Iraq during the summer season of 2009, to study the effect of magnetized water, phosphorus fertilizer rates and their interactions on nutrients uptake by summer squash plant in addition to their effect on some chemical properties of the soil. Composite soil samples were taken randomly from the field before planting. The samples were air dried and analyzed for some physical and chemical characteristics (Table 1).

Table 1: Some physical and chemical Properties of the soil.

Character	Measuring units	Depth (cm)	
		0-15	15-30
pH	1:1 extract	8.03	7.90
EC	dS m^{-1}	0.52	0.41
Total N	g kg^{-1}	1.12	1.12
Available P	mg kg^{-1}	4.12	3.89
K^{+}	Soluble cations (mmole L^{-1})	0.19	0.09
Ca^{+2}		1.74	1.66
Mg^{+2}		0.56	0.54
Na^{+}		0.49	0.41
$CO_3^{=}$	Soluble anions (mmole L^{-1})	Nil	Nil
HCO_3^{-}		4.60	3.60
Cl^{-}		1.00	0.80
$SO_4^{=}$		0. 41	0.37
$CaCO_3$	g kg^{-1}	191.00	198.00
Active $CaCO_3$	g kg^{-1}	105.00	112.00
O.M	g kg^{-1}	16.00	15.00
CEC	Cmol kg^{-1}	34.13	33.71
Clay	g kg^{-1}	497.49	478.55
Silt	g kg^{-1}	458.59	469.95
Sand	g kg^{-1}	43.91	51.48
Soil texture		Silty Clay	Silty Clay

Table 2: Some chemical and physical analysis of water before and after magnetization.

Property	Measuring Units	Magnetic water	Well water
EC	dS m^{-1}	0.85	0.81
pH	---	7.44	7.34
Calcium	mmol L^{-1}	1.00	0.90
Magnesium		3.60	3.60
Sodium		1.23	1.23
Potassium		0.02	0.02
Surface tension	d cm^{-1}	68.20	74.60
Refractive coefficient	---	1.30	1.35
Density	g cm^{-3}	0.98	0.93
Viscosity	---	0.96	0.95

Squash (*Cucurbitapepo* L.) was planted on 18^{th} August 2009 and harvested on 3^{rd} November 2009. Spacing was 30 cm between plants, ridges dimensions were (4 x 1.5 m). Each ridge contained one row, the row contained twelve holes, and three seeds were planted per hole, and then seedlings were thinned to one plant at early seedling stage (2-3 true leaves). Phosphorous was applied as superphosphate (46% P_2O_5) at (0, 90, 180 and 270) kg P_2O_5 ha^{-1} before planting in a line parallel to the plants. Nitrogen fertilizer was applied uniformly to all treatments as urea (46% N) at a rate of 100 kg N ha^{-1} in two equal doses, the first dose was applied at sowing and the second at flowering stage. Potassium was applied as potassium sulfate (52% K_2O) at a rate of 100 kg K ha^{-1} at the flowering stage. Each row had its own irrigation line positioned near the plants. Half of the treatments were irrigated with well water (WW) and the other half with the same water after magnetization (magnetized water (MW)) through magnetism device manufactured by Dubai company of magnetic technology with a magnetic field strength 27.4 mT) (Table 2). Weeds, pests and insects were controlled.

At harvesting stage four plants from each ridge were taken, spread to individual parts, washed, air dried, oven dried at 65 C° for 72 hours, weighed and then ground, wet ashed with acid mixture and kept for analysis. Soil samples were taken between the plants within crop row from each ridge at 0-15 and 15-30 cm. Samples were air dried, ground and sieved through a 2 mm sieve and analyzed for chemical analysis. The data were analyzed according to factorial experiment within randomized complete block design (RCBD), and the differences between means were achieved according to the Duncan multiple range test using SAS 9.0 program.

Results:

Irrigation with magnetized water resulted a significant increase in total dry weight of plant (Fig.1 A). These results were in agreement with those obtained by Makhmoudov, (1998), O'kiely and O'Riodan, (1998). There were also significant differences among phosphorus rates, both P2 and P3 treatments were significantly different (87.89 and 89.88 g $plant^{-1}$) from P1 and the control treatment (82.45 and 70.87 g $plant^{-1}$) respectively. Interactions of P2 and P3 rates with magnetic water gave the highest values of total dry weight 95.5 and 95.8 g $plant^{-1}$ respectively over other interactions and the control treatment (Fig.1 B).

Irrigating with magnetically treated water statistically increased the nitrogen uptake by plant leaves by 16.33% compared to the control (Fig.1 A). The results were in agreement with Al Juboury, (2006). Application of phosphorus fertilizer also increased the nitrogen uptake of the leaves, the highest increase was recorded from P1 (169.09 g $plant^{-1}$). The interaction effects between phosphorus fertilizer and magnetic treatment were significant on nitrogen uptake by leaves Fig.1 (B). Overall, irrigating with magnetically treated water significantly increased nitrogen uptake by leaves, P1 and P2 recorded highest values (184.36 and 181.89 g $plant^{-1}$) respectively.

Uptake of phosphorus by Plants irrigated with magnetically treated water exceeded that of well water by 18.5% (Fig1 A).These results were in agreement with that of Al-Kaabi (2006). Regarding to phosphorus fertilizer rates, P1 gave highest value which was significantly different from P2, P3 and control. Concerning the interaction treatments of water type and P rates (Fig.1 B); there were significant improvements in leaf phosphorus uptake compared to control. The highest value (26.19 g $plant^{-1}$) was obtained with P1 x MW, which was significantly different compared to other interaction treatments and control. This indicated that plants of P2 and P3 with well water treatment had P values as that of P0 with magnetic water. Comparing both P0 treatments of magnetic and well water, magnetically treated plants significantly differ from well water. The phosphorus supply through magnetic treatment may enhance phosphorus uptake and create a more favorable soil moisture condition which improves phosphorus mobility and availability.

Water type highly improved K, Ca, and Mg uptake by plant leaves (Fig.2 A). Phosphorus fertilizer rates also increased leaf uptake of K, Ca and Mg compared to control. The best interaction was achieved with P2 and P3 x MW for K, Ca and Mg (Fig.2 B).

Magnetic treatment significantly improved (stems and branches) N, P, K, Ca and Mg uptake over control treatment by 19.52%, 22.75%, 32.43%, 12.50 and 12.00% respectively (Fig.3 and 4 A).

Phosphorus fertilizer treatments affected nitrogen uptake by (stems and branches), highest value among phosphorus levels was detected with P3 (24.32 g $plant^{-1}$), which was significantly differed from both P1 and control (19.37 and 19.24) g plant^{-1} respectively. Phosphorus uptake in P3 exceeded P0, P1, and P2 by (36.11, 41.66 and 9.72) % respectively, and was significantly different compared to them. P2 and P3 gave the highest K, Ca and Mg uptake by (stems and branches). Regarding the interaction treatments (Fig.3 and 4 B), combination of magnetic water with highest phosphorus rate gave the highest N, P, K, Ca and Mg uptake by (stems and branches) relative to other interactions.

The highest nutrients uptake obtained with magnetic water could be attributed to the indirect effect of magnetic treatment in changing soil physical and chemical properties as well as the activation of microorganisms which could increase the availability and uptake of nutrients (Noran et al., 1996). Degassing of magnetic water increased its permeability in soil, which results in an appreciable increase of irrigation efficiency (Bogatin, 1999). The significant increase in the rate of water absorption accompanied with an increase in total mass of plant with increasing the magnetic force (Reina et al. 2001), improved availability, uptake, assimilation and mobilization of nutrients within plant system and may have contributed in improving the productivity with magnetic treatment (Maheshwari and Grewal, 2009).

Effect of Water Type, Phosphorus Rates, Soil Depth and their Interactions on Some Chemical Characteristics of the Soil

Total nitrogen and soluble K, Ca and Mg were significantly higher in the top 0-15 cm soil depth, however, higher concentration of available P was found at 15-30 cm depth (Table 3 and 4). Adding phosphorus fertilizer stimulated P uptake leaving the 0-15 cm soil depth with lower P level at the end of the growing season (Silberbush and Lips, 1991). In addition, roots are concentrated in the top soil which further stimulates the nutrient uptake from this layer (Mohammed, 2000). Magnetic treatment of irrigation water significantly increased the mentioned nutrients in the soil compared to control. These results were in agreement with (Harari and Lin, 1992), (Noran et al., 1996) and (Al-Juthari, 2006). Magnetic treatment may accelerate the transfer of phosphorus fertilizer into more soluble forms. Many researchers reported an increase in mobile forms of fertilizer with magnetic treatment (Yakovlev et al., 1990) and (Hozayn and Abdul Qados, 2010). Increasing P level up to P3 also increased all nutrients in the soil.

Considering the interaction effect between soil depth and water type (AxB), MW increased N, Ca and Mg in both depths and gave higher concentration at 0-15 cm depth for K and at 15-30 for P. This may be due to possible phosphorus movement deeper in the soil of high rates of P added to the layer; such movement could be attributed to the saturation of the application layer with phosphorus which therefore facilitates phosphorus movement beyond this layer (Mohammed, 2004).

For (A x C) interaction, P1 at 0-15 cm and P3 at 15-30 cm gave the highest values for N. P3 at 0-15 cm recorded the highest significant K, Ca and Mg. For phosphorus, P1 at 15-30 cm gave the highest concentration. The interactive effect of water type and P levels (BxC) showed that almost MW with P2 and P3 level gave the maximum values. The application of P3 level under well water treatment gave P concentration lower than the control treatment. Most of the applied phosphorus probably underwent precipitation reactions in the soil and accumulated as an unavailable form. Therefore, it was reported by Klein, (1999) that P should be added at rates high enough to saturate the adsorption and precipitation capacity of root zone before it being available to plants. With the triple interaction (A x B x C), P1x MW at 0-15 and P3 x MW at 15-30 cm depth gave the highest N concentration. Also P3 x MW at 15-30 cm depth gave the highest P concentration. This could be related to reasons mentioned before. Maximum values of K, Ca and Mg were found with the interaction treatment P3xMW at 0-15 cm depth.

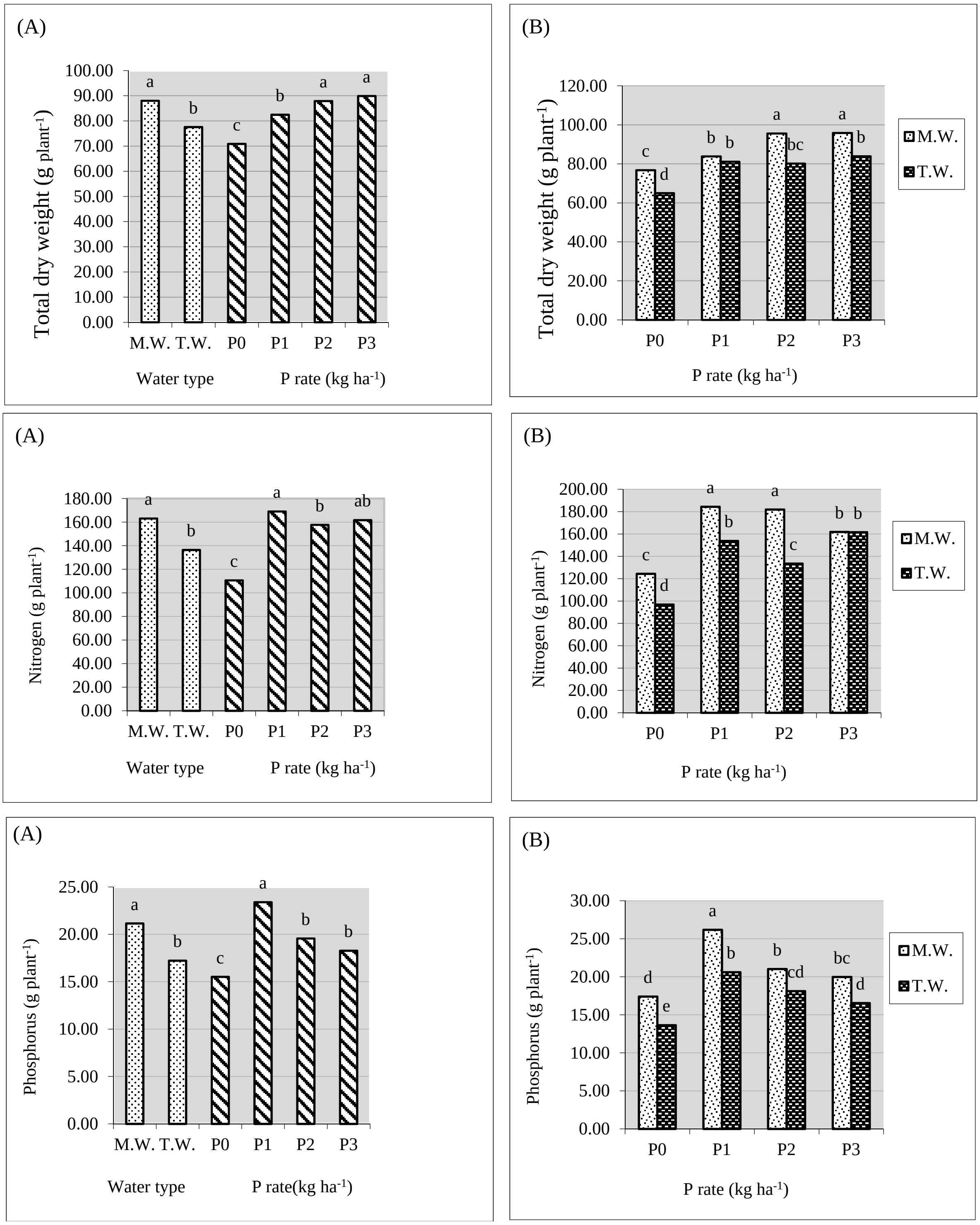

Fig. 1: Effect of water type, phosphorus rates (A) and their interactions (B) on total dry weight, nitrogen and phosphorus uptake (g plant^{-1}) by summer squash leaves.

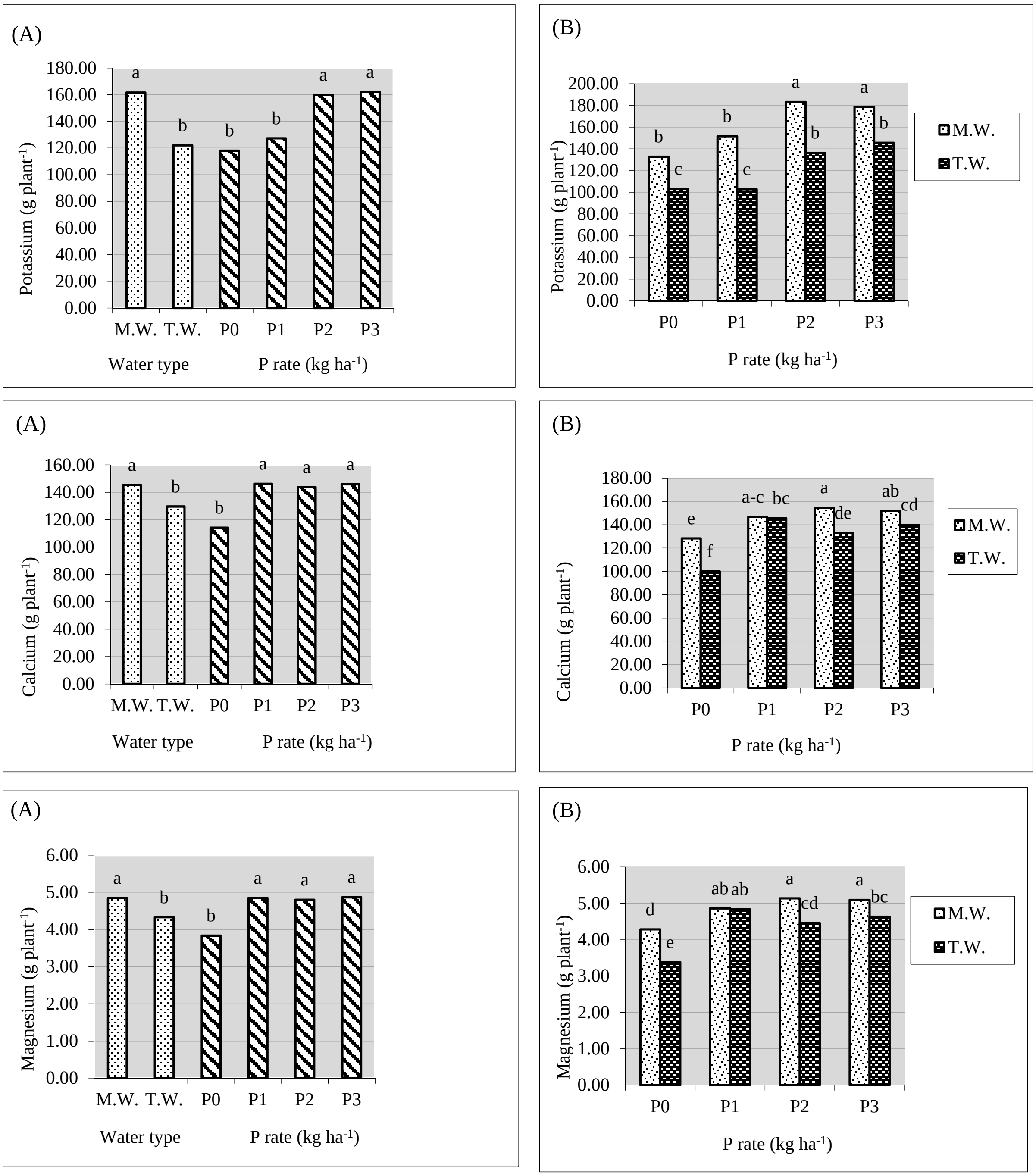

Fig.2: Effect of water type, phosphorus rates (A) and their interactions (B) on potassium, calcium and magnesium uptake (g $plant^{-1}$) by summer squash leaves.

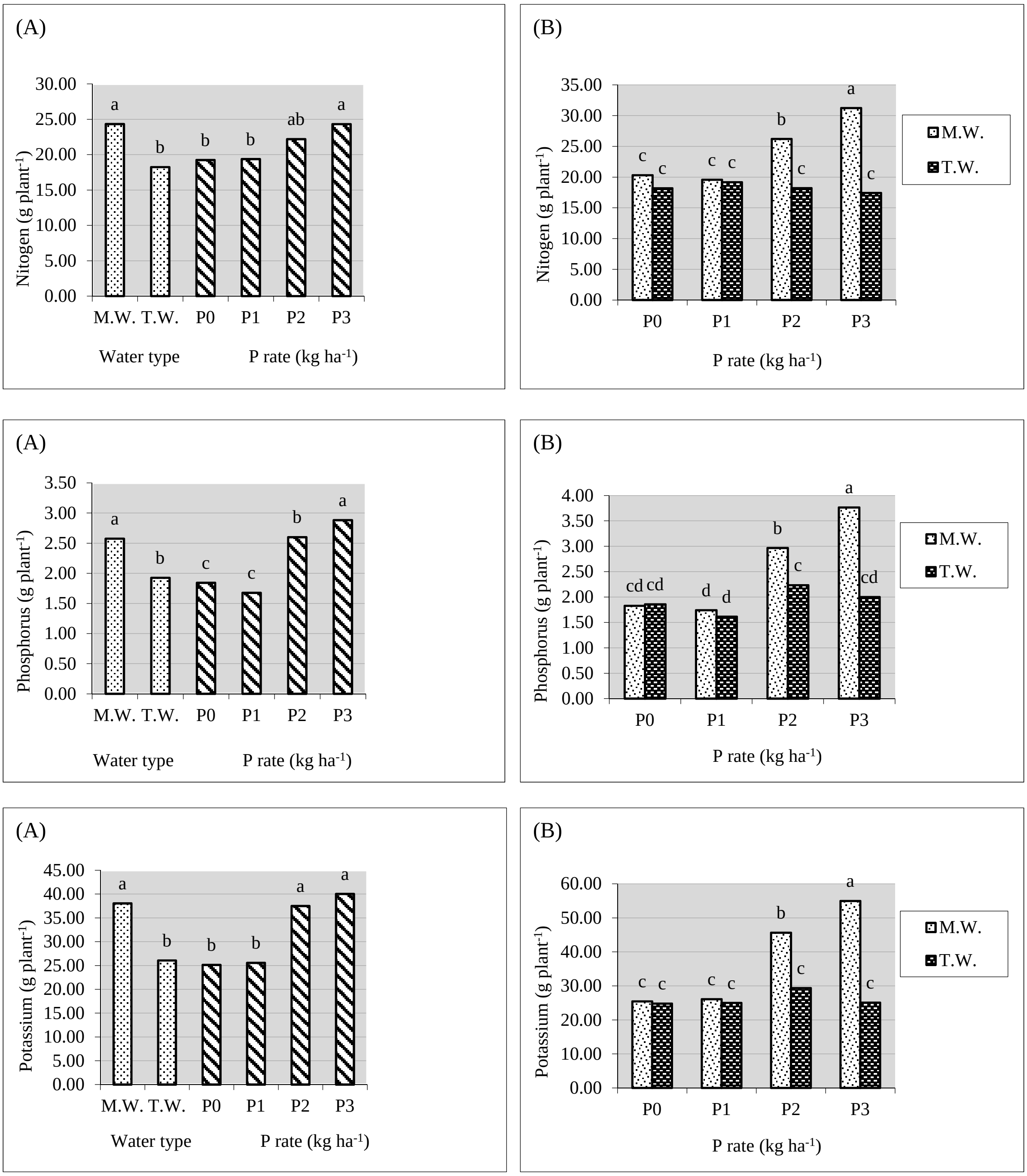

Fig.3: Effect of water type, phosphorus rates (A) and their interactions (B) on nitrogen, phosphorus and potassium uptake (g plant^{-1}) by (stems and branches) of summer squash.

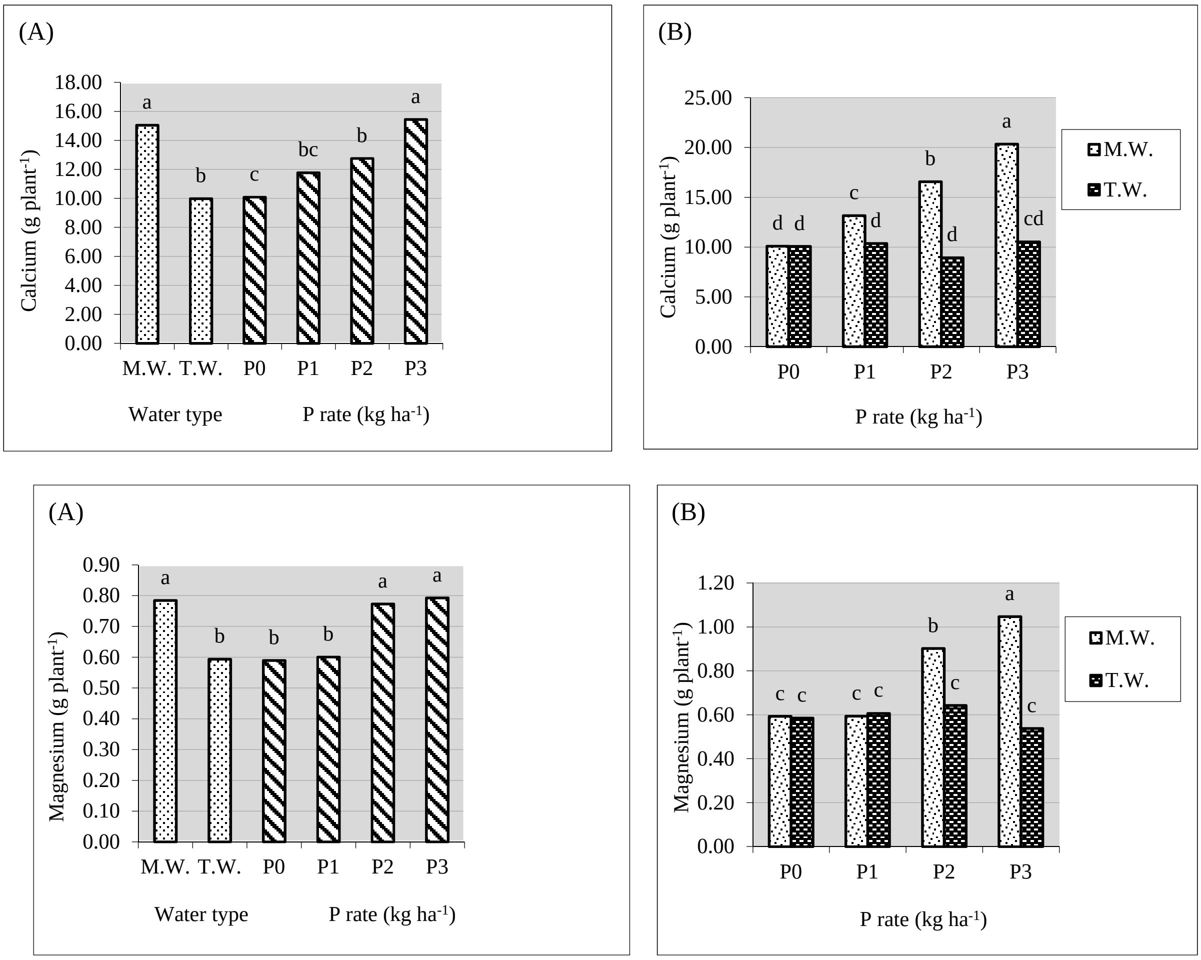

Fig. 4: Effect of water type, phosphorus rates (A) and their interactions (B) on calcium and magnesium uptake (g plant^{-1}) by (stems and branches) of summer squash.

Table 3: Effect of soil depth, water type, phosphorus rates and their interactions on total soil nitrogen in the (g kg^{-1}).

	Soil depth (cm) (A)	Water type (B)	Phosphorus level (C)				A x B	Effect of (A)
			P0	P1	P2	P3		
A x B x C	0-15	MW	1.91c	2.79a	2.24b	2.17b	2.28a	2.01a
		WW	1.86cd	1.75eg	1.71fg	1.69fg	1.75b	
	15-30	MW	1.79df	2.22b	2.26b	2.79a	2.27a	1.94b
		WW	1.82ce	1.17h	1.79df	1.67g	1.61c	
A x C		0-15	1.88d	2.27a	1.97c	1.93cd	Effect of (B)	
		15-30	1.81e	1.69f	2.02b	2.23a		
B x C		MW	1.85c	2.50a	2.25b	2.48a	2.27a	
		WW	1.84c	1.46f	1.75d	1.68e	1.68b	
Effect of (C)			1.84c	1.98b	2.00b	2.08a		

Table 4: Effect of soil depth, water type, phosphorus rates and their interactions on available phosphorus (A), soluble Potassium (B), Calcium (C) and magnesium (D) in the soil (mg kg^{-1}).

A

Soil depth (cm) (A)		Water type (B)	Phosphorus level (C)				A x B	Effect of (A)
			P0	P1	P2	P3		
A x B x C	0-15	MW	4.86de	4.53ef	6.08c	5.75c	5.30b	4.91a
		WW	4.80de	4.66d-f	4.30f	4.34f	4.52c	
	15-30	MW	5.74c	6.74b	6.61b	7.41a	6.63a	5.52b
		WW	4.51fe	4.98d	4.59d-f	3.55g	4.41c	
A x C		0-15	4.83de	4.60e	5.19c	5.04cd	Effect of (B)	
		15-30	5.13c	5.86a	5.60b	5.48b		
B x C		MW	5.30c	5.64b	6.34a	6.58a	5.97a	
		WW	4.65de	4.82d	4.44e	3.95f	4.46b	
Effect of (C)			4.98b	5.23a	5.39a	5.26a		

B

Soil depth (cm) (A)		Water type (B)	Phosphorus level (C)				A x B	Effect of (A)
			P0	P1	P2	P3		
A x B x C	0-15	MW	8.76c	8.99bc	9.33b	10.46a	9.38a	7.97a
		WW	6.51fg	6.14g	7.42e	6.14g	6.55c	
	15-30	MW	7.60de	7.95d	6.60f	7.62de	7.44b	6.77b
		WW	5.69h	6.60f	6.60f	5.55h	6.11d	
A x C		0-15	7.63b	7.56b	8.37a	8.30a	Effect of (B)	
		15-30	6.64d	7.27c	6.60d	6.58d		
B x C		MW	8.18c	8.47b	7.96c	9.04a	8.41a	
		WW	6.10f	6.37e	7.01d	5.85f	6.33b	
Effect of (C)			7.14b	7.42a	7.48a	7.44a		

C

Soil depth (cm) (A)		Water type (B)	Phosphorus level (C)				A x B	Effect of (A)
			P0	P1	P2	P3		
A x B x C	0-15	MW	90.18ef	94.19de	92.18e	111.22a	96.94a	89.61 a
		WW	78.16h	86.65fg	66.13i	98.20cd	82.28b	
	15-30	MW	89.18ef	85.50fg	104.21b	101.76bc	95.16a	86.06 b
		WW	82.16gh	86.39fg	77.15h	62.12i	76.96c	
A x C		0-15	84.17cd	90.42b	79.16e	104.71a	Effect of (B)	
		15-30	85.67c	85.95c	90.68b	81.94de		
B x C		MW	89.68c	89.85c	98.20b	106.49a	96.05a	
		WW	80.16d	86.52c	71.64e	80.16d	79.62b	
Effect of (C)			84.92c	88.18b	84.92c	93.33a		

D

Soil depth (cm) (A)		Water type (B)	Phosphorus level (C)				A x B	Effect of (A)
			P0	P1	P2	P3		
A x B x C	0-15	MW	49.86d	65.36b	51.07d	71.74a	59.51a	54.25 a
		WW	48.64de	42.15g	43.78eg	61.41bc	48.99b	
	15-30	MW	51.07d	57.15c	63.23b	47.42df	54.72c	48.46 b
		WW	44.99eg	42.56f	36.86h	44.38eg	42.20d	
A x C		0-15	49.25cd	53.76b	47.42cd	71.74a	Effect of (B)	
		15-30	48.03cd	49.86c	50.04c	61.41bc		
B x C		MW	50.46c	61.26a	57.15b	47.42df	57.11a	
		WW	46.82d	42.36e	40.32e	44.38eg	45.60b	
Effect of (C)			48.64c	51.81b	48.73c	56.24a		

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کارتێکرنا ئاڤا موگناتیسکری و ئاستێت فوسفوری ل سەر مژینا توخمێت خوارنێ د رووەکێ کولندی دا دناف ئاخێت کسلی دا ل پارێزگەها دهوك

پوخته

ئەڤ ڤەکولینە هاتە ئەنجامدان ل کولیژا چاندنێ/ زانکویا دهوك د ماوێ (تەباخ- چریا دووێ2009) بو دیارکرنا کارتێکرنا ئاڤا موگناتیسکری و ئاستێت جودا جودا ژ فوسفوری (P_0=0، P_1=90، P_2=180 و P_3=270 کغم P_2O_5 هکتار$^{-1}$) و لیگدانێت وان ل سەر وەرگرتنا توخمێت خوارنێ د رووەکێ کولندی دا و هەروەسا کارتێکرنا وان ل سەر هندەك سالوخەتێت کیمیائی یێت ئاخێ. توڤێ کولندی هاتە چاندن د مشاران دا ب دویراتیا 0.5م. پەینێ نایتروجینی و پوتاسی ب رێژێت (100 کغم هکتار$^{-1}$) هاتە زێدەکرن بو هەمی سەرەدەرییان. نیڤا سەرەدەرییان هاتنە ئاڤدان ب ئاڤا بیرێ و نیڤا دی ب ئاڤا بیرێ پتشی موگناتیسکرنێ. ژئەنجامێت ڤەکولینێ ئاڤا موگناتیسکری زێدەبوونەکا بەرچاڤ هەبوو ل سەر کێشا هشکا رووەك، هەروەسا کاریگەریەکا بەرچاڤ هەبوو ل سەر مژینا توخمێت خوارنێ د رووەکی دا و بو ئەگەرێ زێدەبوونا تیراتیا توخمێت حەلیای دئاخێ دا ب تایبەت ل کیراتیا 0–15 سم. سەرەدەرییا (P3xMW) باشترین بهایێت مژینا توخمێت خوارنێ د رووەکی دا دیارکر و بلندترین تیراتیا هەر ئێك ژ کالسیوم، مەگنیسیوم، نایتروجین و فوسفوری د ئاخێ دا.

تاثير الماء الممغنط ومستويات الفسفور على امتصاص العناصر الغذائية لمحصول القرع النامي في الترب الكلسية لمحافظة دهوك

الخلاصة:

نفذت التجربة في حقل كلية الزراعة/جامعة دهوك خلال الفترة (آب- تشرين الثاني-2009) لدراسة تأثير الماء الممغنط ومستويات سماد الفسفور(P_3=270, P_2=180, P_1=90, P_0=0) كغم /هكتار والتداخل بينهما على امتصاص العناصر الغذائية لمحصول القرع وكذلك تاثيراتها على بعض صفات التربة الكيميائية. زرعت بذور(ملا احمد) في مساطب على مسافة 0.5 متر. أضيف سماد النتروجين والبوتاسيوم بمعدل 100كغم/هكتار لكل المعاملات. رويت نصف المعاملات بمياه بئر والنصف الاخربمياه بئر بعد مغنطته. اظهرت النتائج وجود زيادة معنوية للماء الممغنط على الوزن الجاف للنبات كما كان له تاثير معنوي على امتصاص العناصرمن قبل النبات وادى الى زيادة معنوية في تراكيز العناصر والايونات الذائبه في التربة خصوصا للعمق 0-15 سم. أعطت معاملة التداخل (P_3xMW) افضل القيم لامتصاص العناصر من قبل النبات واعلى تراكيز لكل من الكالسيوم ،المغنيسيوم ،النتروجين الكلي و الفسفور في التربة.