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EFFECT OF INORGANIC CHELATED IRON FERTILIZERS ON GROWTH AND YIELD COMPONENTS OF CORN (*ZEA MAYS* L.)

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ABSTRACT

Field experiment was carried out to determine the effects of amounts of inorganic ($FeSO_4.7H_2O$) and chelated (Fe-EDTA) iron fertilizers and also the methods of application (soil application, foliar application) on plant growth Fe uptake and yield. The results showed that the foliar application of iron fertilizers gave better yields and growth component as compared to soil application of iron fertilizers. Results also showed that the chelated fertilizer directly to soil or as foliar gave higher result as compared to inorganic fertilizer.

INTRODUCTION

Iron deficiency occurs in calcareous soils where chemical Fe availability to plant roots is very low (Sharma *et al* . 2004). Improving the fertility status of soil and nutritional status of plant by applying fertilizers is a critical step to increase crop production (Mengel *et al.*, 2001). Little information and not many reports on the behavior of iron in Iraqi calcareous soils and how to solve its plant nutritional problems could be found. The aims of the present study were to assess the importance of inorganic and organic iron fertilizers applied directly to soil or as foliar on growth, Fe uptake and yield components of corn plants.

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MATERIALS AND METHODS

Two field experiments in clay and clay loam soil were conducted in Ninavah Iraq. Five levels of Fe as $FeSO_4.7H_2O$ were applied to clay loam soil (0.0, 4.2, 10.2, 18.0 and 26.9 mg Fe/Kg soil) and to clay soil (0.0, 2.5, 7.5, 15.0and 25.0 mg Fe/kg soil) and as Fe-EDTA were applied soil to caly loam soil (0.0, 2.0, 5.0, 7.5 and 15 mg Fe/kg soil) the same levels of Fe were applied in foliar nutrition to com plant (William variely) . Each experimental unit received 80 kg N/ donum as urea, 50 Kg P/ donum as super phosphate and 30 Kg K/ donum as potassium sulfate.

After 128 days from sowing, corn plants were harvested and grain yield, shoot and root dry weights were recorded. Plant samples from shoots and. roots at harvest time were analyzed for Fe.

RESULTS AND DISCUSSION

Root and shoot dry matter

The dry matter of both root and shoot of corn plants (Tables 1and 2) grown in both locations increased with increasing the amount of Fe applied as $FeSO_4$ or Fe-EDTA to clay loam and clay soils or as foliar application. This increase in shoot and root dry matter might be related to Fe which is an essential element for plant (Mengel *et al.*, 2001). Foliar application of $FeSO_4.7H_2O$ and Fe-EDTA showed more dry matter as compared to soil application of both fertilizers. Chelated fertilizer applied directly to soil or as foliar application gave higher dry matter than inorganic fertilizer. More available Fe in soil with chelated carrier which reflected in more Fe absorption and vegetative growth of corn plants (Lindsay, 1979 and AlMalak, 1986) .

Fe uptake:

Fe absorbed by roots and shoots of corn plants (Tables 3 and 4) grown in both soils increased significantly with increasing the application rate of $FeSO_4.7H_2O$ and Fe-EDTA to soils. Fe-EDTA had superior effects over $FeSO_4.7H_2O$ on the amount of Fe absorbed. This increase may be attributed to the increase of the amount of Fe applied to soils forming more available Fe to be absorbed by plants(Chen and Barak 1982; Khwakaram 2003)

Table (1): Effect of application methods of Fe fertilizers on root dry weight (kg/donum) of corn plants

Application method	$FeSO_4.7H_2O$ (mg Fe/kg soil)					Fe EDTA(mg Fe/kg soil)					Application methods average
	0.0	4.2	10.2	18.0	27.0	0.0	1.7	5.2	8.3	16.5	
Mosul Location (Clay loam soil)											
soil	147.9 i	180.3 h	206.3 d	209.7 b	200.3 g	147.9 i	181.7 h	204.7 f	233.3 b	213.3 c	196.3 b
foliar	147.9 i	187.0 h	201.7 g	241.0 ab	228.0 b	147.9 i	201.0 g	266.3 b	257.0 a	240.0 b	214.4 a
Average	147.9 i	183.7 g	204.0 d	255.3 bc	214.3 b.d	147.9 i	191.3 d	215.5 bc	240.2 ab	266.7 b	
Telkaief Location (Clay soil)											
Application method	$FeSO_4.7H_2O$ (mg Fe/kg soil)					Fe EDTA(mg Fe/kg soil)					Application methods average
	0.0	2.5	7.5	15.0	25.0	0.0	2.0	5.0	7.5	15.0	
soil	215.8 e	237.0 eh	246.7 c-g	270.0 a-d	258.3 b-f	215.8 e	233.3 e-h	274.7 a-c	286.3 ab	254.7 c-f	249.2 a
foliar	215.8 e	242.0 dh	263.0 a-f	273.3 a-d	234.0 c-h	215.8 e	246.3 e-g	257.3 b	290.7 a	267.0 a-c	250.5 a
Average	215.8 e	239.5 d	254.8 bd	271.7 a	246.2 cd	215.8 e	239.3 d	266.0 b	288.0 a	260.8 bc	

Table (2): Effect of application methods of Fe fertilizers on shoot dry weight (kg/donum) of corn plants

Application method	$FeSO_4.7H_2O$ (mg Fe/kg soil)					Fe EDTA (mg Fe/kg soil)					Application methods average
	0.0	4.2	10.2	18.0	27.0	0.0	1.7	5.2	8.3	16.5	
Mosul Location (Clay loam soil)											
soil	246.8 f	303.0 de	345.7 a-c	379.3 bc	358.0 a-c	246.8 f	303.3 d	357.0 cd	387.3 a-c	344.3 bc	323.6 b
foliar	246.8 f	328.7 d	369.3 b	388.7 ab	353.7 c	246.8 f	333.0 b-d	375.3 c	391.0 a	349.0 d	341.9 a
Average	246.8 f	315.8 bc	357.5 bc	384.0 a.c	355.8 a.c	246.8 f	318.2 c	366.2 b	389.2 ab	346.7 b-d	
Telkaief Location (Clay soil)											
Application method	$FeSO_4.7H_2O$ (mg Fe/kg soil)					Fe EDTA (mg Fe/kg soil)					Application methods average
	0.0	2.5	7.5	15.0	25.0	0.0	2.0	5.0	7.5	15.0	
soil	264.7 e	287.7 hi	331.0 f-g	368.0 b-e	340.0 e-g	264.7 e	337.3 e-g	370.3 b-e	394.3 ab	362.0 b-f	331.4 b
foliar	264.7 e	313.0 g-h	343.7 d-g	377.7 d-g	356.0 e-f	264.7 e	344.7 d-g	377.3 a-d	406.3 a	383.7 a-c	344.0 a
Average	264.7 e	300.3 d	337.3 c	372.8 b	348.0 c	264.7 e	341.0 c	373.8 b	400.3 a	372.8 b	

Table (3): Effect of application methods of Fe fertilizers on Fe uptake by roots (kg/donum) of corn plants.

Application method	$FeSO_4.7H_2O$ (mg Fe/kg soil)					Fe EDTA (mg Fe/kg soil)					Application methods average
	0.0	4.2	10.2	18.0	27.0	0.0	1.7	5.2	8.3	16.5	
Mosul Location (Clay loam soil)											
soil	15.9 f	22.1 i	26.8 d-e	30.7 de	26.5 d-f	15.9 f	13.6 h	29.3 de	35.1 c	30.1 cd	26.8 b
foliar	15.9 f	23.2 h	26.1 d-f	33.2 bc	30.8 f	15.9 f	26.9 df	32.8 cd	42.0 ac	35.8 bc	29.6 a
Average	15.9 f	22.7 eh	26.4 d	21.9 bc	28.6 f	15.9 f	23.3 d	31.0 c	38.6 b	32.8 c	
Telkaief Location (Clay soil)											
Application method	$FeSO_4.7H_2O$ (mg Fe/kg soil)					Fe EDTA (mg Fe/kg soil)					Application methods average
	0.0	2.5	7.5	15.0	25.0	0.0	2.0	5.0	7.5	15.0	
soil	21.2 e	32.4 cd	35.3 b-d	41.7 a	36.6 bc	21.2 e	32.4 c-e	39.4 a-b	44.1 a	36.4 bc	34.8 a
foliar	21.2 e	27.1 e-g	30.5 d-f	35.8 b-d	27.5 e-g	21.2 e	30.6 d-f	35.0 b-d	44.5 a	34.5 b-d	30.7 b
Average	21.2 e	29.8 d	32.9 cd	38.8 b	32.1 cd	21.2 e	31.6 d	37.2 b	44.3 a	35.5 bc	

Table (4): Effect of application methods of Fe fertilizers on Fe uptake by shoots (kg/donum) of corn plants.

Application method	$FeSO_4.7H_2O$ (mg Fe/kg soil)					Fe EDTA (mg Fe/kg soil)					Application methods average
	0.0	4.2	10.2	18.0	27.0	0.0	1.7	5.2	8.3	16.5	
Mosul Location (Clay loam soil)											
soil	30.6 g	39.3 ef	46.8 e	58. bc	50.2 e	30.6 g	41.9 ef	54.2 d	63.5 c	51.2 de	46.6 b
foliar	30.6 g	49.9 de	58.9 b	64.1 ab	55.3 c	30.6 g	53.9 c	61.9 a-c	69.0 a	54.4 cd	55.3 a
Average	30.6 g	44.6 de	52.8 c	61.1 b	52.8 c	30.6 g	47.9 d	58.1 bc	66.2 h	82.8 c	
Telkaief Location (Clay soil)											
Application method	$FeSO_4.7H_2O$ (mg Fe/kg soil)					Fe EDTA (mg Fe/kg soil)					Application methods average
	0.0	2.5	7.5	15.0	25.0	0.0	2.0	5.0	7.5	15.0	
soil	34.3 i	41.8 h	50.8 f-g	59.8 b	51.8 e-g	34.3 i	51.0 f-g	58.2 h-e	65.2 a-b	56.5 c-f	50.4 b
foliar	34.3 i	45.5 g-h	51.6 eg	58.9 b-d	51.7 e-g	34.3 i	52.6 d-f	60.1 b-c	60.1 a	59.8 b-c	50.4 a
Average	34.3 i	43.7 d	51.2 c	59.3 b	51.8 c	34.3 i	51.8 c	58.2 b	62.7 a	58.2 b	

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Corn yield:

The results in (Table 5) showed that the grain yield of corn increased with increasing the amount of $FeSO_4.7H_2O$ and Fe-EDTA applied. Higher shoot and root growth and more Fe uptake with increasing of Fe applied were reflected in more grain yield of corn plants (Havlin *el al.*, 1999). Foliar application of Fe carriers showed better yield as compared to soil application of both fertilizers. The results also showed that chelated fertilizer Fe- EDTA applied directly to soil or as foliar gave better grain yield as compared to inorganic fertilizer $FeSO_4.7H_2O$. This increase in yield might be attributed to the higher availability of Fe to plant under foliar application and with chelated fertilizer applied to soil.

Table (5): Effect of application methods of Fe fertilizers on grain yield (kg/donum) of corn plants

Application method	$FeSO_4.7H_2O$ (mg Fe/kg soil)					Fe EDTA (mg Fe/kg soil)					Application methods average
	0.0	4.2	10.2	18.0	27.0	0.0	1.7	5.2	8.3	16.5	
Mosul Location (Clay loam soil)											
soil	1888.3 i	2272.0 n	2573.3 g	3574.7 e	2884.0 f	1888.3 i	2173.3 n	2760.0 f	3158.7 d	3104.0 e	2709.8 b
foliar	1888.3 i	2533.3 g	3061.3 de	3544.0 bc	30747 e	1888.3 i	2806.7 ef	3328.0 cd	3986.7 a	3289 c	3056.9 a
Average	1888.3 i	2402.7 c	2817.3 ef	3309.3 bd	2979.3 d	1888.3 i	2490.0 fg	3044.0 d-g	3572.7 b	3196.5 cd	
Telkaief Location (Clay soil)											
Application method	$FeSO_4.7H_2O$ (mg Fe/kg soil)					Fe EDTA (mg Fe/kg soil)					Application methods average
	0.0	2.5	7.5	15.0	25.0	0.0	2.0	5.0	7.5	15.0	
soil	1900.5 l	2178.7 k	2566.7 h	3156.0 d-f	3056.9 g	1900.5 l	2292.0 j	3130.7 cf	3390.7 b	3160.0 d-f	2758.6
foliar	1900.5 l	2320.0 g	2996.0 g	3248.0 cd	3097.3 f	1900.5 l	2466.7 i	3133.3 bc	3746.7 a	3220.0 c-e	2788.4
Average	1900.5 l	2249.3 f	2781.3 d	3202.0 b	3077.3 c	1900.5 l	2379.3 e	3132 b	3568.7 a	3190.0 b	

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الملخص العربي

تأثير مخصبات الحديد المخلبي غير العضوي على النمو

أجريت تجربة حقلية لتقدير تأثيرات كميات المخصبات: المخصب الحديدي غير العضوي ($FeSO_4.7H_2O$) والمخصب الحديدي المخلبي (Fe-EDTA) وكذا طرق التطبيق (معاملة التربة ، معاملة المجموع الخضري على نمو النبات ومقدرته على أخذ الحديد والناتج المحصولي). وأوضحت النتائج أن معاملة المجموع الخضري بالمخصب الحديدي أعطى أعلى نمو وإنتاج ومحتوى النمو بالمقارنة بمعاملة التربة بالمخصبات الحديدية.

وأوضحت النتائج أيضا أن استخدام مخصب الحديد المخلبي على التربة مباشرة أو باستخدامه على المجموع الخضري أعطى أعلى نتائج مقارنة بمخصب الحديد غير العضوي.