BORON DESORPTION IN DIFFERENT CALCAREOUS SOILS TEXTURE

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ABSTRACT

This study was conducted to investigate boron (B) desorption in three calcareous soils with different texture (clay, loam and sandy loam). The experiment included study boron desorption with time at three temperatures and use 11 time periods between 0.0-720 hours at temperatures of 5, 25 and 35° C.

The results revealed that boron desorption decreases with increasing incubation time from 0.0-720 hours for all incubation temperatures; also the increase in temperature from 5 to 35 ° C increased the boron desorption.

The results also showed the effect of soil texture in boron desorption whereas, the loamy soil outperformed compared with the other soils by given the highest values of boron desorption (16.5 mg Kg^{-1}).

INTRODUCTION

Boron (B) desorption is one of the most important factors in deciding the efficiency of B fertilization and its management in intensively cultivated soils (4). Boron release reactions in soil have been studied less than adsorption reactions (10) and the results on the reactions of boron adsorption in soil are contradictory. In some soils, B desorption isotherm is almost identical with adsorption isotherm (6). While another soils showed hysteresis, in which the boron adsorption isotherm did not match with the B desorption (10, 17) and soil boron adsorbed was completely release after many cycles of sequential extraction and during desorption, boron diffused slowly from the interior of clay lattice to the solution phase (13).

Various anion sorption mechanisms can clearly show irreversibility B adsorption reactions involving ligand exchange, bidentate surface complexes and integration into clay mineral lattice. The ligand exchange depends on pH and reverses with changes in pH. However, release

negative ions at constant pH shows different degrees of irreversibility (15).

A variety of soil properties have been identified as affecting the behavior of B in soils. Clay mineral types, clay content and specific surface area, sesquioxides, organic matter content, soil pH and salinity have been influence the B distribution in liquid and solid phases in soil (8).

This study was conducted to evaluate boron release under different temperatures in different calcareous soils texture at different time periods.

MATERIALS AND METHODS

Soil samples were collected from three different calcareous soils from central of Iraq. Each soil was mixed separately, a representative sample was

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taken for each texture air dried, passed through a 2- mm sieve to estimate some chemical and physical soil characteristics (Table 1).

In order to evaluate boron desorption from boric acid, a known weight of this acid was used with a 20 mg B kg^{-1} concentration and solvent in calcium chloride solution (0.01 M). Three temperatures 5, 25 and 35°C were used. Weight of 100 g of dry soil 0.05mm diameter was incubated in 125 gm plastic pots and 0.5 ml of Toluene was added to inhibit soil microbiology activity, soil moisture was maintained at 80% of field capacity through incubation periods. After each incubation period, boron was extracted by hot water (5) and estimated by Plasma Atomic Emission Spectrometer (ICP) model ICPE- 9000 SHIMADZU.

Table 1: Soil chemical and physical characteristics

Character	unit	Value		
		Clay	Loam	Sandy loam
Sand	gm kg^{-1}	162.63	428.7	755.53
Silt		378.03	368.7	80.16
Clay		459.33	202.6	164.33
Texture		Clay	Loam	Sandy loam
EC 1:1	dSm^{-1}	0.72	7.47	0.16
pH 1:1		7.50	6.82	7.69
Calcium carbonite	g kg^{-1} soil	238.3	250.0	256.0
Organic mater	g kg^{-1} soil	20.0	1.98	4.0
NH4- N	mg N Kg^{-1} soil	40.88	30.92	12.32
NO3- N		14.7	10.42	7.7
Available-P	mg Kg^{-1} soil	18.21	23.51	13.29
Available-Ca	C mole +kg^{-1} soil	74.49	81.425	46.52
Available-Mg		5.48	5.95	1.80
Available-K		7.58	9.83	1.16
Available-Na		867.78	863.98	71.65
Boron (H.W)	mg Kg^{-1} soil	3.050	1.268	0.147

RESULTS AND DISCUSSION

Results showed that B desorption from boric acid (fertilizer source) decreases with increasing incubation period from 0.5 to 720 hours for all three incubation temperatures Fig (1, 2). Maximum values are 16.0, 16.5 and 18.2 mg kg^{-1} at 0.5 hours for (5, 25 and 35 °C) the above temperatures respectively (Fig 1). Lowest values were 12.0, 12.8 and 13.1 mg kg^{-1} at the last incubation period (720 hours) at incubation temperatures of 5, 25 and 35 ° C, respectively (Fig 2). This result indicates that B turns with time into other forms less soluble as a result of various retention processes and thus release rate decreases. These results are consistent with Majidi et al. (16) and Al-Ameri (1) who demonstrated that a large part of adsorbed boron releases relatively easy by diluting equilibrium solution, implying that outer- sphere complexation is the major binding mechanism for B adsorption in calcareous soils. This was confirmed by Goldberg and Su (12), who noted that boron forms weak outer-sphere complexes; this physically bound B could be readily leached and would be available for plant uptake. Suarez and Goldberg (12) noted that boron release decreased as time function and one month incubation period can be obtained a very good indication (19).

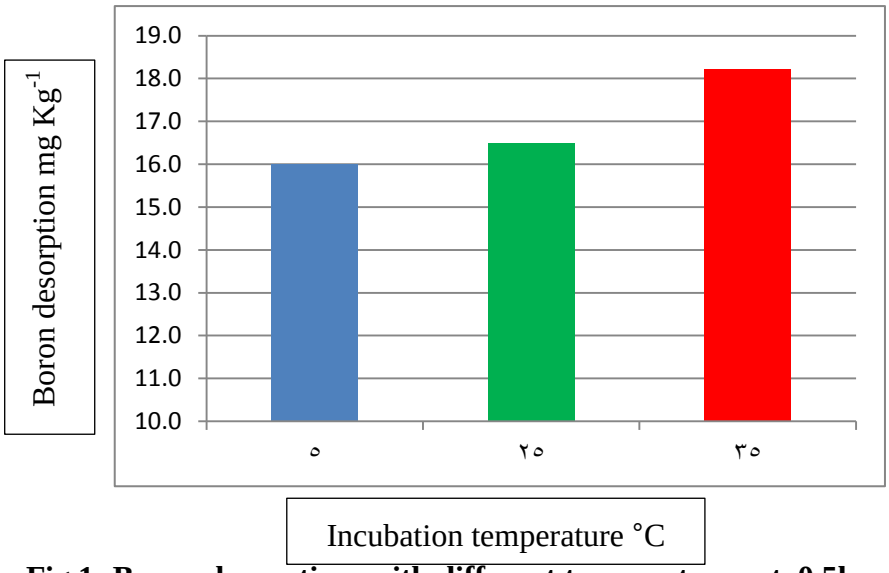

Fig 1: Boron desorption with different temperatures at 0.5hours.

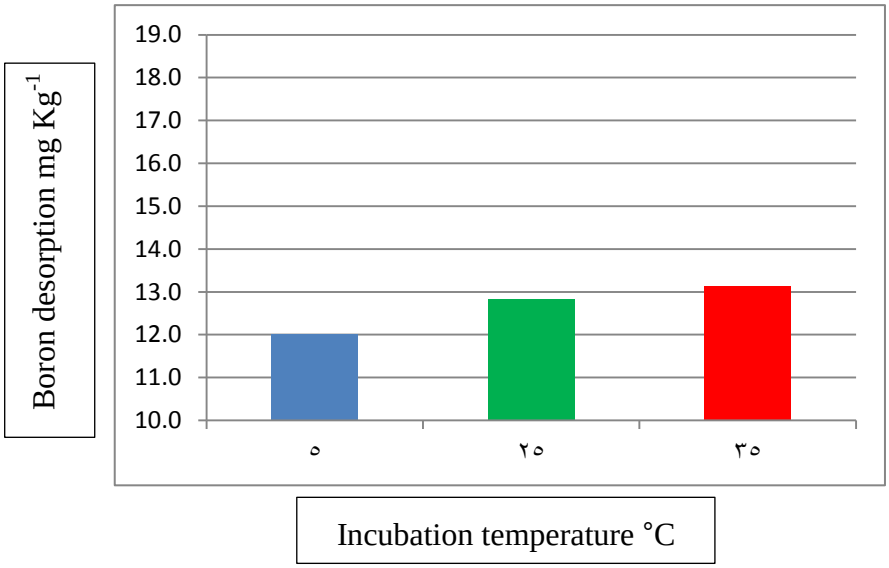

Fig 2: Boron desorption with different temperatures at 720 hours.

It was also observed that B desorption for the three temperatures were relatively rapid at short time reaction (0.5 hours), which causing release of 85.6, 82.4 and 92.6% from added B at zero time (t=0) with all temperatures, 5 , 25 and 35° C, respectively. While at 720 hours it reached 64.35, 64.2 and 65.5% from B added at zero time (t=0) and for temperatures 5, 25 and 35 ° C, respectively. Boron desorption average for the incubation periods decreased from 0 to 0.5, 24 and 720 hrs. and at 5°C by 5.9, 14.0 and 29.2%, while it decreased by 2.5, 12.9 and 24.1% for the above periods respectively at 25° C. Decreased percentage was 4.2, 18.8 and 32.0% for those periods respectively. The decrease in boron desorption as a general average for the three temperatures was 4.2, 13.9 and 28.4% for incubation periods 0.5, 24 and 720 hours compared to zero time.

Results showed that B desorption average rate for all three soils and the three temperatures was 86.9, 76.8 and 64.7% from added boron of incubation periods 0.5, 24 and 720 hours respectively (Fig 1, 2), the average desorption rate decreased by 24.7% at incubation time 720 hrs. compared to the incubation time

of 0.5 hrs. as it appears that the first boron release (0.5 hrs.) is relatively rapid and then decreases gradually and becomes slowly during at last incubation period (720 hours). This behavior can be explained by the fact that boron reactions in short times (t<0.5 hour) is a fast reactions and the follow reactions (t> 0.5 hrs.) is slow, this is due to the fact that release at the short periods seems easy because of the lack time for boron exposure to sorption reactions (adsorption and precipitation) or configure complex with elements and carbonate minerals in soil, on the other hand at along periods (720 hours) there is enough time for these reactions to occur. This result is consistent with several studies have focused on the release of B and other elements, whether macro or micronutrients in different soil systems (1,3,4,16).

The increase of incubation temperature resulted in an increase in the B desorption rate (Fig. 1, 2) and this was confirmed by exponential equations, which indicated a positive correlation between the B desorption (Y) and temperature (T) at first incubation time (0.5 hours):

$$\text{Ln } Y = 2.7754 + 0.039T \qquad (r = 0.661)$$

During last incubation time (720 hours) according to the following equation:

$$\text{Ln } Y = 2.5482 + 0.0006T \qquad (r = 0.679)$$

These two equations indicated that B desorption from boric acid (source of fertilizer) and for two incubation periods increased by 0.039 and 0.0006 mg B kg $^{-1}$ per 1 °C. The effect of temperature in desorption of this ions is likely to have an effect on the desorption sites, which increase the speed of its release and transfer it to the soil solution. This is consistent with kinetic chemistry basic, where increasing the temperature to raise the speed of many of the reactions that take place according to whether in free systems or soil systems and biological system (1, 3, 6, 7).

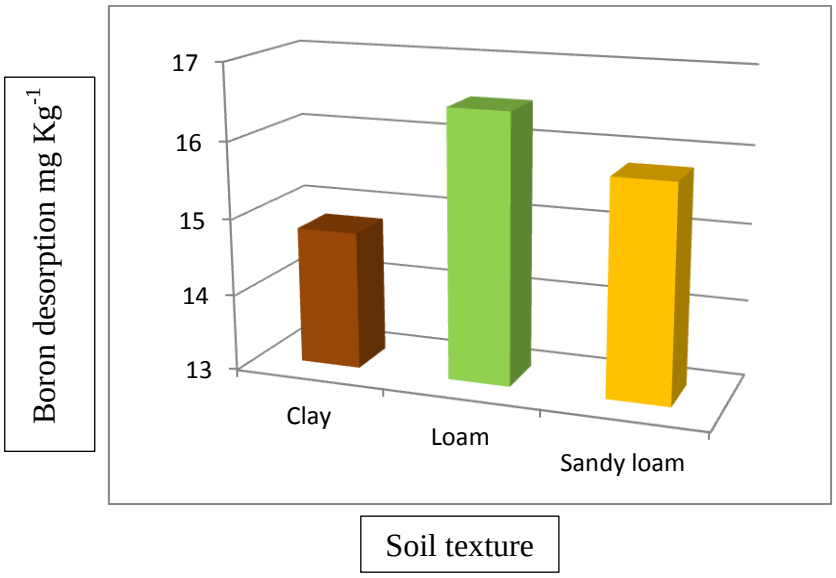

Fig 3:Soil texture effect in B desorption.

Boron desorption was affected by soil texture (Fig. 3) for all incubation periods and the three temperatures. Loamy texture exceeded the rest of the soils giving the highest value of B desorption. It averaged 16.9, 16.5 and 16.1 mg kg $^{-1}$

for 5, 25 and 35° C with mean average of 16.5 mg kg $^{-1}$. Clayey texture soil was 14.3, 13.7 and 16.0 mg kg^{-1} for temperatures 5, 25 and 35 °C, respectively, with mean average of 14.7 mg kg^{-1} while 16.3, 15.0 and 16.0 mg Kg^{-1} . Sandy loam soil and mean average of 15.8 mg^{-1} kg.

Boron fertilizer desorption increased in Loamy soil by 18.2, 20.4 and 0.63% compared to Clay soil at temperatures 5, 25 and 35°C. Loamy soil excelled in desorption B fertilizer at Clay soil by 13.1%. The desorption of B in Loamy soil compared to Sandy loam soil increased by 3.6, 10.0 and 0.63% at the above temperature respectively, where Loamy soil excelled in the desorption of fertilizer B on Sandy loam soil by 4.7% as the increase in clay content led to a decrease in the B release rate (fig. 3), clay is the dominant factor in controlling the release of boron in the soil. This was confirmed by the exponentil equation, which indicated a negative correlation between Boron desorption (Y) and clay content (X):

$$\text{Ln } Y = 2.8339 - 0.0003\ X \qquad (r = 0.864)$$

This equation showed that boron desorption decreased by (0.0003) for each increase of 1.0 gm kg^{-1} of clay. Similarly, Chahal and Arora (4) also reported that total desorbable B was negatively correlated with clay content (r= -0.93), Datta and Bhadoria (9) also pointed that adsorbed B is dependent on soil texture, and increases with increasing clay content (1, 14).**

In general, B desorption from boric acid for all incubation periods and temperatures were the largest amount in Loamy texture for containing suitable clay content.

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تحرر البورون في ترب كلسية مختلفة النسجة

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الملخص

تهدف هذه الدراسة الى تحري اطلاق البورون في ثلاث ترب كلسية مختلفة النسجات (طينية ومزيجة ومزيجة رملية)، مع الزمن عند ثلاث درجات حرارة مختلفة (٥، ٢٥ و٣٥°م)، وباستعمال ١١ مدة زمنية بين ٠.٠– ٧٢٠ ساعة.

اظهرت النتائج ان اطلاق البورون يتناقص طردياً مع زيادة مدة التحضين من ٠.٠– ٧٢٠ساعة ولدرجات حرارة التحضين الثلاثة جميعها في حين ادت زيادة درجة الحرارة من ٥– ٣٥°م الى زيادة اطلاق البورون.

كما بينت النتائج تأثير نسجة التربة في اطلاق البورون،اذ تفوقت التربة المزيجة على بقية الترب في اعطاء اعلى قيمة لأطلاق البورون بلغت ١٦.٥ ملغم كغم$^{-1}$.

وزارة العلوم والتكنولوجيا، بغداد، العراق.