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An Investigation into Some Effects of the Interaction Between Aggregate Size, Water Content and Incubation Periods on Potassium Release of Calcareous Soil

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Abstract: In a laboratory study using calcareous soil, six sizes of soil aggregates (i.e. 25-20, 20-10, 10-5, 5-2, 2-1 and less than 1 mm in diameter). Two levels of moisture content (i.e. 50 and 100% of available water) were applied by using risen technique to investigate potassium release from the soil along with five periods of incubation (i.e. 1, 2, 4, 6 and 8 weeks) under controlled temperature of 25±1°C. The results showed that potassium release increased with decreasing aggregate size of soil. The treatment of 100% of available water gave higher values of liberated potassium than the treatment of 50% available water for any given size of soil aggregate and incubation period. There was obviously a positive relationship between potassium liberation and the applied incubation period.

Key words: Potassium release, aggregate size, available water, incubation period

INTRODUCTION

Potassium considered as an essential element for plants. Since this element is important particularly in arid and semi arid regions as a result it faces many changes which affected by different factors specially solid phase factors such as soil texture[1,2] and soil structure[3] who pointed out to the importance of soil structure and its role in potassium release. They reported that fine sizes of soil aggregates cause higher liberation of potassium than larger sizes of soil aggregates. On the other hand clay minerals[4], organic matter content[5] as well as lime content[6] have an effective action on potassium liberation process.

There are many indirect factors that influencing potassium release such as temperature, pH and cations in soil solution besides soil moisture[7,8].

Since there is no studies so far that observe the relation between soil structure and potassium release in calcareous soils under dry farming conditions, so this study was directed to investigate the effect of different structural aggregates as well as moisture levels on potassium release besides increate a mathematic modeling description for potassium liberation process in calcareous soil within a semi sufficient rains area of northern Iraq.

MATERIALS AND METHODS

Representative soil samples of calcareous soil that classified within great soil groups as calciorthid were taken from a field in the college of agriculture and forestry, Mosul University, Iraq. Physical and chemical characteristics are shown in Table 1, according to the method in Klute[9] and Page *et al.*[10]. Soil aggregate groups were dried and separated by dry sieving using the following sieves; 25, 20, 10, 5, 2 and 1 mm in diameter in which there were six size ranges (i.e. 25-20, 20-10, 10-5, 5-2, 2-1 and less than 1 mm in diameter). A 5 g of resin saturated with calcium according to Sparks[8] was prepared and then put in a piece of mesh rags and tied carefully then put it into a plastic container. A 100 g on oven dry weight base of each group of soil aggregate size were put over the resin samples according to Heming and Rowell[3] The samples were subjected to two moisture levels (i.e. 50 and 100% of available water) and then incubated

Table 1: Physical and chemical characteristics of calcareous soil used

Particle size distribution	
Sand	43.5%
Silt	24.0%
Clay	32.5%
Bulk density	1.40 g cm^{-3}
Particle density	2.66 g cm^{-3}
Permanent wilting point	14.0%
Field capacity	24.0%
Saturation capacity	38.0%
Soil pH	7.8
Calcium carbonate	16.3%
Organic matter	0.53%
Soluble potassium	0.3 m mole kg^{-1}
Exchangeable potassium	7.6 m mole kg^{-1}
Non exchangeable potassium	18.3 m mole kg^{-1}
Mineralogical potassium	225.0 m mole kg^{-1}
Total potassium	246.0 m mole kg^{-1}
Clay minerals	
Smectite	21.5%
Illite	41.0%
Kaolinite	18.5%
Chlorite	19.0%

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under constant temperature of 25±1°C for the periods, 1, 2, 4, 6 and 8 weeks. After each period of time resin samples were taken out and treated with hydrochloric acid one Normal according to Sparks[8]. Potassium was calculated in the extract according to Page *et al.*[10].

RESULTS AND DISCUSSION

Data in Table 2 reveals a decrease in potassium released with increasing aggregate size for any period of incubation. This finding agreed with Heming and Rowell[3] for their study on soil aggregates that ranged between 2-3 mm down to less than 0.8 mm. Addiscott[11] also confirmed the same direction of this result. This can be attributed to the fact that using large soil aggregate will lead to decrease specific surface area that exposed to exchange with the resin for a given size of soil; in other words with large size of aggregates within a specific volume of space the total pore spaces will be less than when using small particles. However in one hand the quantity of potassium liberated was found between 5-63 mg kg^{-1} for the aggregate size of 25-20 mm whereas the quantity reached the value of 141-250 mg kg^{-1} for the aggregate size of less than 1 mm with 50%available water treatment. On the other hand with 100% available water treatment the quantity of liberated potassium becomes nearly the double in comparison with the 50% treatment (i.e. 20-115 and 300-475 mg kg^{-1} for the aggregate sizes 25-20 and less than 1 mm respectively). This observe the role of wetting process in increasing potassium liberation which is coincided with the confirmation of Chakrarartes and Pahaik[7], Badrawi[12] and Sparks[8] that moisture has an effective action on potassium liberation due to expanding the lattices of clay minerals which in turn increase potassium liberation; in which this lead to transfer

Table 2: Potassium liberation quantities during different incubation periods (Potassium release mg kg^{-1})

Moisture content (%)	Aggregate size (mm)	Incubation period (Days) 7	14	28	42	56
50% Available water						
	25-20	5	37	46	52	63
	20-10	21	56	73	85	91
	10-5	50	72	100	135	156
	5-2	86	91	120	163	181
	2-1	125	151	170	186	206
	<1 mm	141	183	200	232	250
100% Available water						
	25-20	20	41	78	99	115
	20-10	61	80	143	161	186
	10-5	92	161	201	246	291
	5-2	156	200	250	295	345
	2-1	231	272	316	390	405
	< 1 mm	300	350	420	452	475

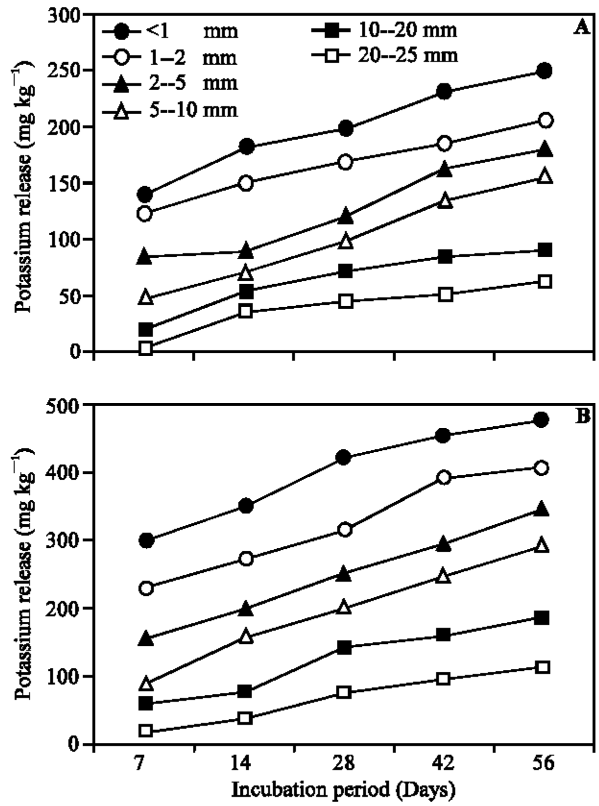

Fig. 1: Relation between potassium release and incubation period: (A) With 50% available water, (B) with 100% available water

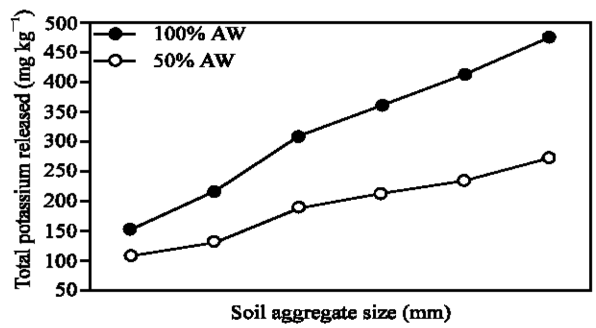

Fig. 2: Relationship between total potassium release and size of soil aggregate

potassium via dispersion process to the extract which is acting to increase potassium exchange on clay mineral surfaces.

A perusal of Fig. 1 reveals that potassium release increased with increasing incubation period[13,14]. This pointed out that potassium liberation process needs enough time to reach the maximum quantity of potassium liberation. On the other hand the Fig. 1 shows that release process would completed through two stages of reaction, the first is a quick liberation process which reflects the exchangeable stage while the second stage is slow liberation which reflect the non exchangeable stage in potassium liberation process[15] .

Figure 2 shows that for a given aggregate size, potassium release was found higher with 100% available water than with 50% treatment.

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