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VALLEY (SPAIN)

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S U M M A R Y

The Q/I ratios of contrasting soils of the Saragossa Province (Spain) were studied. Samples of the soils were treated with varying quantities of a monocalcium phosphate solution to yield ranges of 0 to 400 ppm applied P. The samples were incubated at saturation for one week, after which they were placed in Buchner funnels. P was determined in water extracts obtained by suction.

These quantities of P were plotted against the amounts of applied phosphorus and the resulting P-sorption curves were found to differ widely among soils.

The results obtained were significantly affected by the nature and the concentration of salts present in the soils.

Soils with much sodium chloride and calcium sulphate had higher P-sorption capacities than had those with calcium chloride.

Those containing calcium and sodium sulphates showed positive correlations between salt concentration and phosphate sorption.

Maximum P adsorption values were strongly influenced by degree and nature of salinity. A sequence was obtained according to the composition of the salt present. That is: sodium calcium sulphates > sodium chloride + calcium sulphate > calcium chloride + sodium sulphate > sodium chloride and sodium sulphate. The range of the values was: (667 to 200 ppm P) (425 to 320 ppm P) (348 to 223 ppm P) and 233 to 127 ppm P respectively.

I N T R O D U C T I O N

Nutrient supply to the soil solution is affected by the Q/I ratio (Khasawneh and Copeland 1973, For and Kamprath 1970). Thus the phosphorus concentration in soil solution is vital since it should contain sufficient phosphorus to provide the concentration gradient necessary of this nutrient to the roots (Olsen and Watanabe 1963, 1966).

Therefore it is necessary to know exactly what the Q/I ratio is. It has been defined by sorption isotherms, which may be obtained through laboratory procedures such as equilibrating soil samples in phosphorus containing solutions or by incubating water saturated soil with added P.

T A B L E I
Some properties of the experimental soils.

Soil-Type	pH		% Ca CO ₃ total	% Organic matter	% N	C/N	Exchangeable potassium mgK/100 g soil	EC. (mmhos/cm) in 1:5
	water	1N Kcl						
Maral	8.3	7.9	33.9	1.3	0.09	8.2	28.5	10.9
Serosem	7.9	7.7	30.7	1.1	0.08	7.8	24.6	4.8
in Tauste	8.1	7.8	33.9	0.8	0.10	4.8	25.5	2.2
Maral	8.7	8.6	25.3	0.2	0.06	2.1	16.1	4.4
Serosem	8.8	8.6	24.5	0.1	0.06	0.8	19.4	6.8
in Granen	8.7	8.2	24.5	0.3	0.06	2.9	9.8	1.7
Maral	7.8	7.5	37.8	1.6	0.11	8.1	49.2	11.6
Serosem	7.9	7.6	37.1	1.5	0.13	6.6	42.0	7.1
Belchite	8.8	7.6	47.0	1.4	0.09	9.5	28.6	2.4
Gypsum	8.8	8.5	33.2	0.4	0.04	5.0	11.4	10.8
Serosem	8.1	7.8	37.8	0.8	0.09	5.0	7.6	3.1
Bujaraloz	8.1	7.7	30.4	0.7	0.08	4.6	10.2	3.7

According to the purpose of the study, and soils used, one or the other method may be chosen.

In this case, the Q/I ratio of saline soils was evaluated under similar conditions to those corresponding to field conditions.

MATERIAL AND METHODS

Soils which represent important agricultural localities of the Saragossa Province (Spain), were chosen. They were: Tauste, Granen, Belchite Bujaraloz.

The soils were calcareous (Tables 1 and 2) and showed a great variation with regard to E.C. values (Table 1). The composition and concentration of the influenced by ions such as: calcium, magnesium, sodium, chloride and sulphate. There was a predominance of chloride over sulphate. This was more evident in some soils than in others (see Table 2).

As aforesaid the purpose of this study was to relate the Q/I ratio to the P applications. For that reason, incubation at saturation water level was chosen.

The soil was enriched with 0, 10, 50, 100, 150, 200, 250, 300, 350 and 400 ppm P as monocalcium phosphate solutions.

After a week of incubation this mixture was placed in a Buchner funnel. A water extract was obtained by suction and P in the extract was analysed by the method of Watanabe and Olsen (1965).

Soil pH was determined in a ratio (1:2) soil/water mixture or soil /1 N potassium chloride solution, by a glass electrode (pH meter Beckman Dv.)

Calcium carbonate total and active were obtained by the Bernard and Droinneau procedures respectively, described by Droinneau and Gouny (1951).

Organic carbon according to the Walkley and Black method (1934) and the organic matter is obtained applying a factor 1.72.

Total nitrogen through the method of Kjeldahl, using selenium as catalyzer.

It was used the ratio (1:5) (soil/water) and it was read the Electrical Conductivity in this extract and was expressed in mmhos/cm.

Soil available potassium was extracted by a 1 N ammonium acetate solution buffered at pH 7. It was used a soil/solution ratio (1:10) and an equilibrium time of 15 minutes. The K in the extract was analysed by flame-photometry.

RESULTS AND DISCUSSION

The phosphorus sorption curves for these soils are shown in Fig. 1, A, B, C and D.

Three different patterns may be seen related to the dominance of chloride or sulphate salts. Thus, the phosphorus sorption increased with the amount of sodium chloride in presence of calcium sulphate (see Fig. 1 A).

T A B L E 2

Salinity in saturation extract.

soil	EC. mmhos/ cm	Cations and anions in saturation extract (m.e./per litre)										Cation Anion ratio
		Ca	Mg	K	Na	Cl	So ₄	Co ₃	HCo ₃			
Maral	34.89	56.40	47.10	1.35	250.00	264.13	104.16	0.00	1.87	0.96		
Serosem in Tauste	15.89 6.96	40.00 16.00	45.00 16.00	0.88 0.64	77.40 35.47	41.44 10.76	0.00 0.00	1.91 2.16	0.96 0.97	0.96		
Maral	16.76	15.30	8.30	0.76	169.00	109.33	70.70	0.00	4.77	0.99		
Serosem in Granen	23.48 9.13	11.19 16.31	6.12 5.30	0.44 0.38	216.42 76.67	163.11 58.76	71.70 38.26	0.00 0.00	4.93 3.25	0.97 0.98		
Maral	34.89	164.00	83.00	4.80	70.30	309.50	18.10	0.00	2.23	0.97		
Serosem in Belchite	21.98 4.49	108.00 35.50	74.80 16.60	3.11 1.67	67.30 4.70	227.30 21.87	29.00 34.65	0.00 0.00	2.26 1.99	0.98 0.99		
Gypsum	23.68	29.10	49.00	2.42	127.50	72.53	187.78	0.00	4.47	0.96		
Serosem in Bujaraloz	7.39 7.92	37.00 32.70	23.70 31.80	0.52 0.32	16.83 18.75	8.27 15.29	68.51 65.83	0.00 0.00	2.77 2.40	0.98 1.00		

The soil with the highest degree of salinity was mainly due to sodium chloride salt and a certain amount of calcium sulphate, exhibits a slope of sorption curve that was steeper than those of the others two soils. The decrease of P sorption was also related to the lowering of the salt content. (Fig. 1B).

When the salt dominant consisted of a mixture of sodium sulphate and sodium chloride, a similar pattern to that seen in Fig. 1 A was found and it agreed with that reported by Singh and Tabatabai (1976).

The phosphorus sorption curves changed with the presence of salts such as calcium chloride plus some sodium sulphate and the opposite situation was obtained. That is for soil with high salt content, a low P sorption curve of values was reached. However, the differences among these three phosphorus curves (Fig. 1 C) are not so spectacular than in the cases mentioned before.

Phosphorus sorption values were lower than those obtained in the case of the presence of sodium chloride (Fig. 1 A).

When the salinization was produced by a combination of sodium and calcium sulphates (Fig. 1 D). There exists a positive relation between P sorption and salinity.

As long as it would be important to know the influence of the salt on the P sorption values by soil, the calculation of the maximum P adsorption and the binding constant must be taken into account in order to show the above mentioned differences.

In all these soils, the relation between P sorbed (factor Q) and phosphorus in the soil solution (factor I) followed a Langmuir Isotherm which can be written as follows:

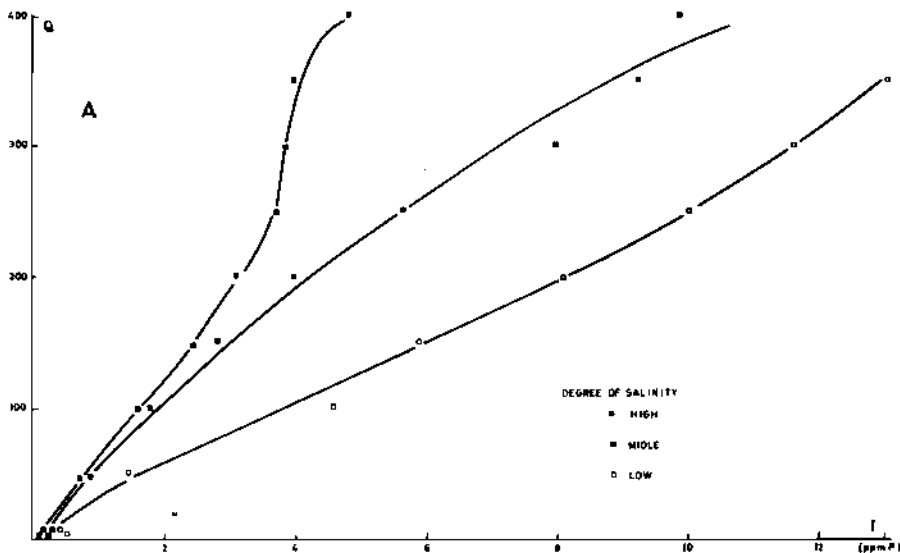


FIG 1 Q/I ratio in saline soils (mg/100g)

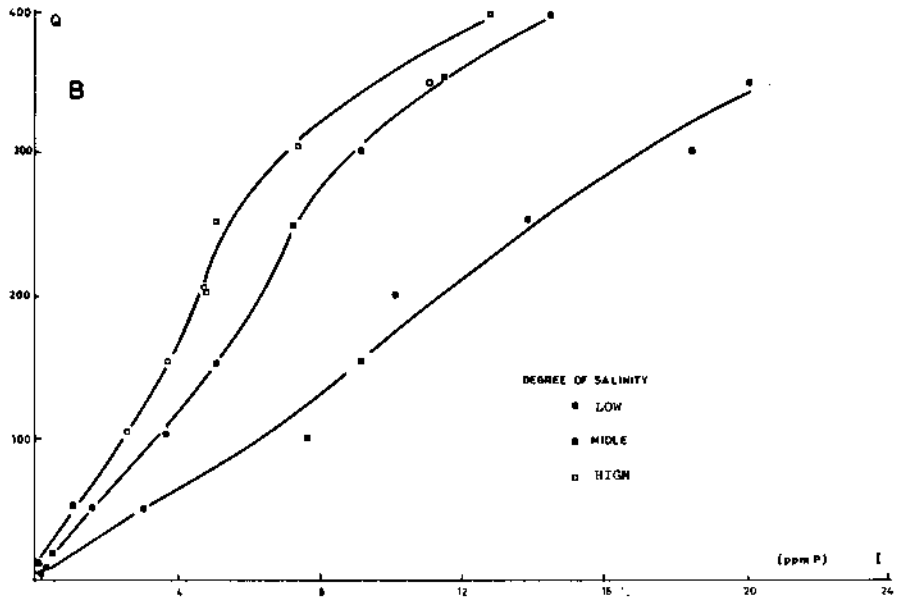


FIG. 1.—Q/l ratio in saline soils (GRANEN).

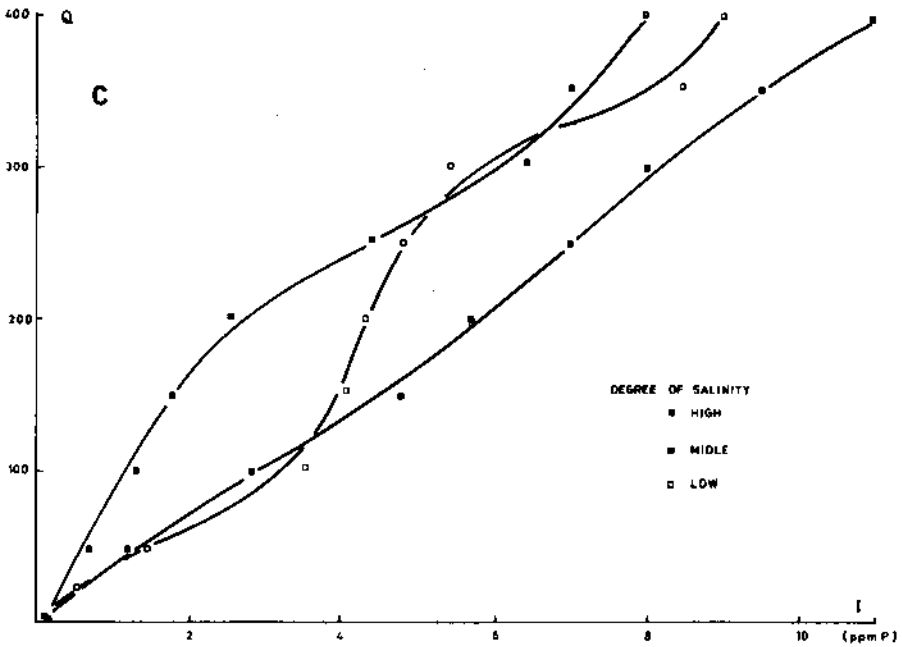


FIG. 1.—Q/l ratio in saline soils (Belchite).

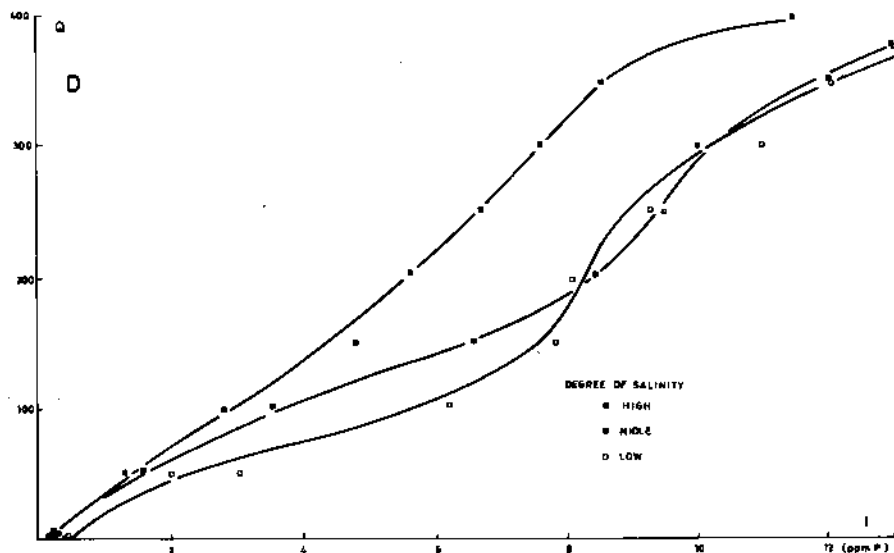


FIG. 1.—Q/I ratio in saline soils (Bujaraloz).

$$Q = K_1 C / K_2 + C \quad (1) \quad (\text{Khasawneh and Copeland 1973})$$

where:

$C = P$ In the soil solution

$K_2 =$ Maximum P adsorption

$K_1 =$ Binding constant between soil and phosphate.

The above equation (1) can be transformed into an equivalent equation such as:

$$C/Q = K_2/K_1 + C/K_1 \quad (2)$$

From this equation (2) it would be possible to calculate the maximum P adsorption and the binding constant through applying a regression analysis between C/Q and C values. At the same time the point at which P concentration in the soil solution produces an adsorption in molecular form can be found (Figs 2A, B, C and D).

Again, the same patterns were followed but soils according to the dominance of a chloride or sulphate salt. That is, with a similar phosphorus concentration in the soil solution, soils which were rich in sodium chloride showed lower values in the C/Q ratio than those with a medium and low degree of salinity (see Fig. 2 A).

At the same time, it also indicated that the process of adsorption like molecular layer took place at different P concentration in the soil solution. They ranged between (2 to 8 ppm PP), which agreed with the findings of Lehr and van Wesemael (1952) related to the disponibility of plant available phosphate in presence of a high salt concentration.

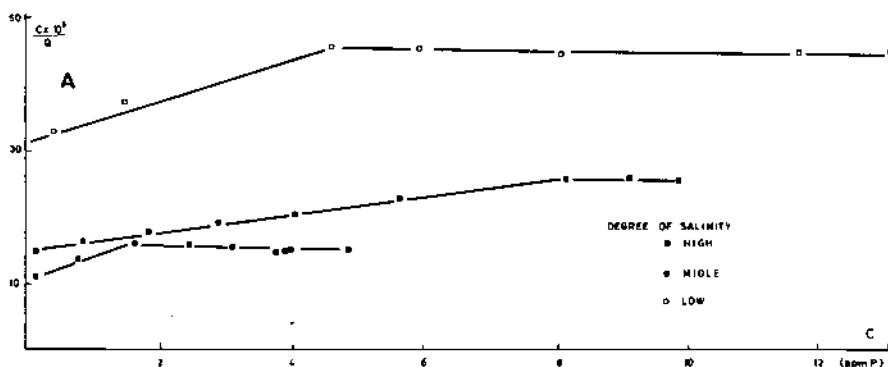


FIG. 2.—Relationship $\frac{C \times 10^5}{Q}$ and C for saline soils (Tauste).

In the case of a mixture of sodium chloride and sodium sulphate, the situation was more or less similar to that before described (see Fig. 2 B). There was only a little difference related to the P concentration, where it was followed the process of adsorption for soils with high and medium degree of salinity. Under these conditions, it was attained at similar phosphorus values in final solution (see Fig. 2 B). It seemed that both the forms of sulphate and chloride prevented the disponibility of this nutrient for a plant.

Soils with high contents of calcium and magnesium chlorides showed different behaviours related to the drawings of C/Q and C (Fig. 2 C). Similar patterns were found for the low and high saline soils. The process of adsorption was only followed until a great value of phosphorus in the soil solution (5 ppm P) (See Fig. 2 C).

While the range of the P concentration in the gypsum Serosem soils at which the adsorption mechanism was produced, were between 6 to 8 ppm P. In spite of salinity, these soils followed similar behaviours very common in calcareous soils described by Olsen and Watanabe (1957), and some of the Ebro valley reported by Eleizalde (1976).

The chemical nature involved in this phosphorus adsorption by saline calcareous soils is very complicated because a part of P can be adsorbed by CaCO_3 surface or some can be precipitated from solution, probably as ortocalcium phosphate, and deposited on the adsorbed layer (Barrow (1980).

Another fact which is clear, is that the P adsorption is very dependent of the concentration and composition of the salt present in the soil solution. Allowing an extra mechanisms by which the adsorption increased potential of the soils (Singh and Tabatabai 1976).

The values of maximum P adsorption and constant of binding between this element and soil, can be seen in Table 3. Independent of the concentration, a sequence of the maximum P adsorption values is obtained, according to the composition of salt present. That is: sodium plus calcium sulphates > sodium chloride plus calcium sulphate > calcium chloride plus sodium sulphate > sodium chloride and sodium sulphate.

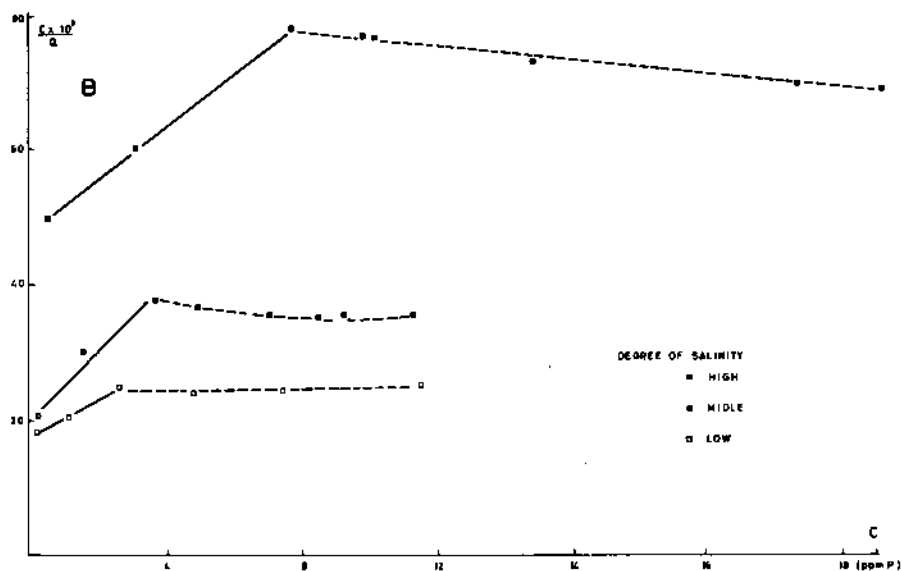


FIG. 2.—Relationship $\frac{C \times 10^3}{Q}$ and C for saline soils (Graffen).

The range of the values is comprinded: 667 to 200 ppm P), (425 to 320 ppm P), (348 to 253 ppm P) and (233 to 127 ppm P).

Differences were also found related to the binding constant values, which were markely influenced by the concentration of salt present, and they ranged from 15.20 to 2.13.

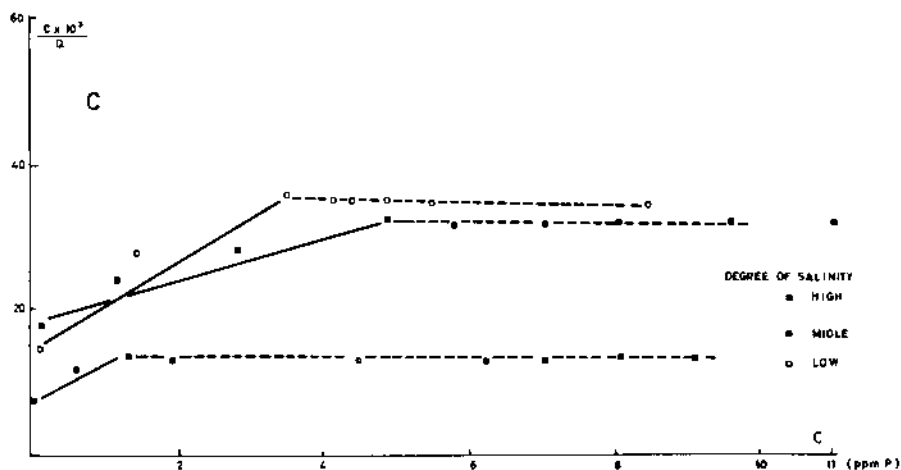


FIG. 2.—Relationship $\frac{C \times 10^3}{Q}$ and C for saline soils (Belchite).

TABLE 3

Maximum P adsorption and binding constant values for these soils expressed as ppm and ml/g respectively

Soil	EC. mmhos/cm	Mixture of salts	Maximum P adsorption	Binding constant
Maral	34.89	sodium	425.0	10.73
Serosem	15.86	chloride	375.0	4.43
in Tauste	6.96	+ calcium sulphate	320.0	3.39
Maral	16.76	sodium	233.0	10.86
Serosem	23.48	sulphate	223.0	4.22
in Granen	9.13	+ sodium chloride	127.0	5.68
Maral	34.89	calcium	348.0	6.67
Serosem	21.98	chloride	258.0	4.13
in Belchite	4.49	+ sodium sulphate	253.0	2.13
Gypsum	23.68	sodium	667.0	15.20
Serosem	7.39	sulphate	199.0	6.10
in Bujaraloz	7.92	+ calcium sulphate	463.0	12.79

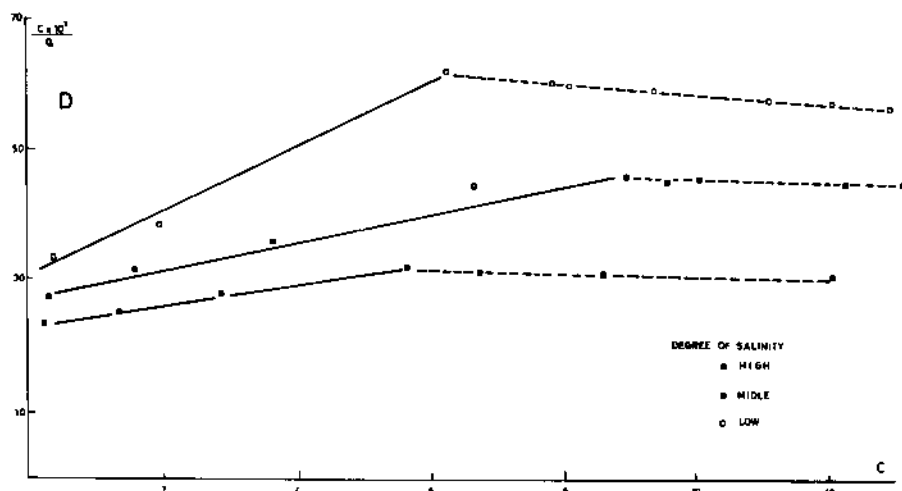


FIG. 2.—Relationship $\frac{C \times 10^3}{Q}$ and C for saline soils (Bujaraloz).

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