Silicon extraction in fertilizer with Na_2CO_3 + NH_4NO_3 in the autoclave

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Introduction

An extraction method of silicon in slag and fertilizers was developed to quantify the potentially available Si for the plants. The method is based on the solubilization of the Si content materials in an alkaline extractor. This study aimed at evaluating variations in the use of Na_2CO_3 + NH_4NO_3 as extractors of Si in fertilizers and induced by autoclave.

Materials and methods

An experiment completely randomized with the rice culture, in a Quartzipsamment soil under greenhouse was installed with 18 Si sources applied at a rate of 250 kg ha^{-1} and a control with four replication.

Table 1 – Characteristics of Si sources studied and amounts applied in each treatment.

	Treatments	Provided silicate			Dose per pot (2)		
		Si	Ca	Mg	Silicate	$CaCO_3$	$MgCO_3$
		-----g kg^{-1}-----			------ g. pot^{-1} --------		
1.	Control	-	-	-	-	13,4	2,5
2.	Wollastonite	235	303	1	2,7	11,4	2,5
3.	Blast Furnace S Si-AF (4, 5)	179	215	45	3,5	11,5	1,9
4.	Blast Furnace S CSN-AF	156	304	31	4,0	10,3	2,1
5.	Blast Furnace Slag Aco-AF	134	200	38	4,7	11,0	1,9
6.	Blast Furnace Slag Us-AF	160	159	27	3,9	11,8	2,1
7.	Blast Furnace Slag Pi-AF	165	166	8	3,8	11,8	2,4
8.	Blast Furnace Slag Ac-AF I	191	304	31	3,3	10,9	2,1
9.	Blast Furnace S Ac-AF II	200	156	6	3,1	12,2	2,4
10.	LD furnace steels Si-LD	57	293	44	10,9	5,4	0,8
11.	LD furnace steels CSN-LD	51	201	46	12,3	7,2	0,5
12.	LD furnace steels Aco-LD	52	197	17	12,0	7,5	1,8
13.	LD furnace steels Ac-LD I	50	186	46	12,5	7,6	0,5
14.	LD furnace steels Ac-LD II	64	238	73	9,8	7,6	0,0
15.	AOD furnace steels AOD	47	403	35	13,3	0,0	0,9
16.	Phosphorus solub. slag	215	311	4	2,9	11,1	2,5
17.	Stainless steel slag Ac	108	262	57	5,8	9,6	1,4
18.	Silicate clay	263	6	11	2,4	13,3	2,4
19.	Schist	247	15	10	2,5	13,3	2,4

(1) NP = neutralization power, calculated and determined respectively of Si sources; (2) $CaCO_3$ and $MgCO_3$ dose to balance the Ca and Mg contents applied with treatments; (3) %E $CaCO_3$ = equivalent percentage in $CaCO_3$ of 100g of product; (4) material of the companies: Si=Silifertil, CSN=National Siderurgica company, Aco=Açominas, Us=Usiminas, Pi=Pitangui, Ac=Acesita; (5)Designation given to the type of furnace used to convert iron into steel.

It was applied four silicon extractors solutions in sources: Solution 1: Na_2CO_3 (0,1 mol.dm^{-3}) + NH_4NO_3 (0,2 mol.dm^{-3}); Solution 2 - Na_2CO_3 (0,1 mol.dm^{-3}) + disodium EDTA (0,03 mol.dm^{-3}) + NH_4NO_3 (0,2 mol.dm^{-3}); Solution 3 - Na_2CO_3 (0,1 mol.dm^{-3}) + disodium EDTA (0,03 mol.dm^{-3}) + NH_4NO_3 (0,2 mol.dm^{-3}) + $C_2Na_2O_4$ (0,06 mol.dm^{-3}) and; Solution 4 - Na_2CO_3 (0,1 mol.dm^{-3}) + disodium EDTA (0,03 mol.dm^{-3}) + NH_4NO_3 (0,2 mol.dm^{-3}) + CH_3COONH_4 (0,1 mol.dm^{-3}).

The procedures used for Si analysis include weighing 0.1 g of each source and transfer into 250 cm^3 bottle autoclavable polypropylene. Then were added 50 cm^3 of solution "A" (Na_2CO_3 or Na_2CO_3 + EDTA), it was shaken the bottle to homogenize the samples and then added 50 cm^3 of solution "B" with new manual shaking. The bottles were taken to an autoclave for 1 hour at 121 °C.

Results

Table 2. Effect of Si sources on dry mass yield, Si content in the dry mass of rice and total of Si extracted by rice.

Treat.	Dry mass yield		Si content in the dry mass		Si accumulated in the dry mass	
	- g.pot^{-1} -		- g.kg^{-1} -		- g.pot^{-1} -	
1.	24.1	a (1)	17.7	ad	425.1	bc
2.	27.7	a	20.9	ac	607.8	ab
3.	28.7	a	15.7	cd	450.3	bc
4.	26.9	a	14.4	d	386.7	c
5.	29.7	a	15.9	bd	470.1	ac
6.	27.5	a	17.9	ad	492.9	ac
7.	27.2	a	17.0	ad	462.7	ac
8.	25.2	a	18.8	ad	473.3	ac
9.	27.2	a	16.8	ad	457.0	ac
10.	27.9	a	19.4	ad	541.0	ac
11.	28.2	a	22.4	a	629.3	ab
12.	32.1	a	17.7	ad	569.7	abc
13.	29.2	a	21.7	ab	633.3	ab
14.	26.8	a	20.3	ad	543.4	abc
15.	31.9	a	22.2	a	676.2	a
16.	24.4	a	22.5	a	550.7	ac
17.	25.9	a	21.5	ac	556.8	ac
18.	26.4	a	17.5	ad	462.7	ac
19.	28.6	a	16.0	bd	487.8	ac
C.V.	15.4		12.1		16.5	
D.M.S. 5%	11.1		5.9		221.3	

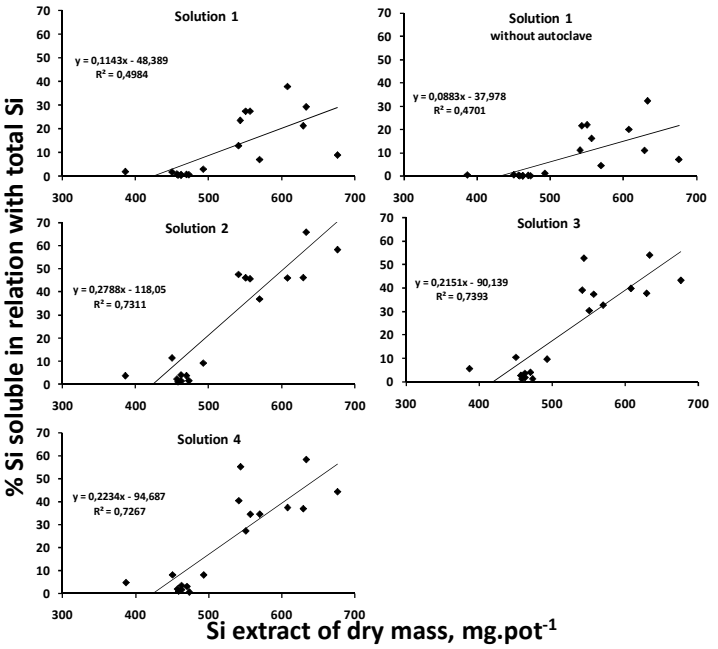

Fig 1. Correlation between Si extract of dry mass and percentage of soluble Si in relation with total Si of the sources.

Conclusion

The autoclave was efficient in increasing the Si extraction, replacing the 5 days rest in the sample in solution. The highest extraction and better correlation between soluble Si and Si uptake by the rice crop was obtained in solutions with EDTA.

Acknoledgements

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