EFFECT OF CALCIUM CARBONATE CONCRETIONS ON PHOSPHORUS AVAILABILITY TO THE CROPS

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ABSTRACT

A pot experiment was conducted at Soil Chemistry Section, Ayub Agricultural Research Institute, Faisalabad during 2001-2003. Five treatments i.e. 0, 3, 6, 9 and 12 percent $CaCO_3$ concretion (CCC) by weight of soil were tested in two separate sets of pots. One set was used for raising wheat and maize crops and the other was kept without crops to collect soil samples. The results indicated no significant effect of CCC on crops yield as well as P availability. Average grain yield of three wheat crops indicated that higher grain (51.3 g/pot) was produced by control (0% CCC) and lowest (45.3 g/plot) by 12 percent CCC. Higher average fodder yield of two maize crops (247.0 g/plot) was obtained from control and lowest (237.0 g/pot) from 12 percent CCC being statistically at par. Increasing levels of CCC induced a slight decrease in P availability but effect was non-significant. In case of wheat, average Olsen P in soil varied from 22.0 (12% CCC) to 27.0 μg/g (control) during first year. In second year P varied from 20.0 (12% CCC) to, 24.0 μg/g (control) while in third year it ranged from 23.0 (12% CCC) to 26.0 μg/g (control). In maize crop same pattern was observed during first and second year.

KEYWORDS: *Triticum aestivum; Zea mays;* Calcium carbonate; phosphorus; Pakistan.

INTRODUCTION

Phosphorus is second major essential plant nutrient that plays an important role in energy producing processes called phosphorlylation (12). Its availability is a problem in calcareous soils due to its fixation and conversion into less available forms (9, 2, 11). Most of the soils in Pakistan are alkaline in nature, affecting the P availability. Applied P reacts readily with $CaCO_3$ resulting in low availability (3, 5, 7). Gutam and Tomar (6) reported that $CaCO_3$ has more affinity to orthophosphate-sorption. Many workers studied the effect of soil properties on the availability of P and found that soils having more $CaCO_3$ have less P availability. The information reported is perhaps about the size of clay but not about the lime concretions.

In present study, effect of $CaCO_3$ concretions was studied on P availability by using wheat and maize crops as test crops.

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MATERIALS AND METHODS

Pot experiments were conducted at Soil Chemistry Section, AARI, Faisalabad during the year 2001-2003. Five levels of $CaCO_3$ concretions (CCC) i.e. 0, 3, 6, 9 and 12 percent by weight of soil were developed in pots by mixing CCC in sieved soil. For this purpose, a light textured soil rich in CCC was selected. The soil was sieved and CCC were separated. Then ten kg of sieved soil was taken, CCC mixed in the soil according to treatments and pots were filled with this soil. Two sets of pots were prepared, one for crop sowing and other for drawing soil samples. Wheat and maize crops were raised in rabi and kharif seasons, respectively. N, P and K were applied as recommended dose (150-80-80 mg/kg) to both crops. Second set of pots was irrigated to keep soil moisture at field capacity but no crop was grown. From these pots, soil samples were collected after an interval of 30 days during the year 2001 and at 15 days interval during 2002 and 2003. The experiment was repeated during 2002 and 2003. Soil samples were analyzed for Oslen P (13).

RESULTS AND DISCUSSION

Wheat grain yield

The results (Table 1) revealed that grain yield of wheat during the year 2001 decreased with the addition of CCC in soil. Highest grain yield (66 g/plot) was obtained in control and lowest (56 g/pot) in treatment receiving 12 percent CCC. The reduction in grain yield was also significant at 12 percent CCC as compared to control while other treatments were at par. The effect of CCC on succeeding wheat crop grown during the year 2002 and 2003 was non-significant. Grain yield varied from 50 to 47 and 38 to 33 g per pot during the year 2002 and 2003, respectively, by increasing CCC from 0 to 12 percent. On mean basis, no bad effect of added CCC was observed on average grain yield.

Table 1. Effect of calcium carbonate concretion on wheat grain yield (g/pot).

CCC(%)	2001	2002	2003	Mean
0	66a	50 NS	38NS	51.3NS
3	60ab	50	35	48.3
6	60ab	49	35	48.0
9	59ab	49	33	47.0
12	56b	47	33	45.3

NS = Non-significant

Maize fodder yield

The results (Table 2) revealed that application of CCC did not decrease the maize fodder yield and had no significant hampering effect on P availability to maize crop during both years. Maize fodder yield varied from 254 to 242 and 240 to 232 g per pot during the year 2001 and 2002, respectively. It was maximum in control (254 g/pot) and minimum (242 g) in 12 percent CCC treatment. However, the difference between treatments was non-significant. Average fodder yield of 2 years also indicated that CCC addition in soil had no bad effect on fodder yield (Table 2).

Table 2. Effect of calcium carbonate concretion on fresh maize fodder yield (g/pot).

CCC(%)	2001	2002	Mean
0	254NS	240NS	247.0NS
3	251	236	243.5
6	248	234	241.0
9	243	234	238.5
12	242	232	237.0

NS = Non-significant

Availability of phosphorus

Treatments mean indicated that CCC did not decrease the available P contents in soil to a significant level. Olsen P varied from 27 to 22 μg/g in various treatments, maximum in control and minimum in 12 percent CCC (Table 3). However, all the treatments were found statistically at par.

Table 3. Effect of calcium carbonate concretion on P availability (μg/g) during winter (rabi) 2001.

CCC(%)	Sampling interval (days after CCC application)			Mean
	15	45	75	
0	26 NS	26NS	28NS	27NS
3	26	26	25	26
6	24	24	23	24
9	23	24	22	23
12	23	23	22	22

NS = Non-significant

Phosphorus in soil samples taken after 15, 45 and 75 days of CCC application was almost the same. During the year 2002 and 2003, sampling interval reduced from 30 days to 15 days. The average P in soil varied from 24.0 to 20.0 and 26.0 to 23.0 μg/g in various treatments during the year 2002 and 2003 respectively. It was higher in control and minimum in 12 percent CCC application (Table 4 & 5).

Table 4. Effect of calcium carbonate concretion on P availability (μg/g) during winter (rabi) 2002.

CCC (%)	Sampling interval (days after CCC application)						Mean
	15	30	45	60	75	90	
0	22NS	20NS	23NS	27NS	20NS	23NS	24NS
3	23	20	22	27	18	21	22
6	22	20	21	24	20	20	21
9	21	18	21	24	19	22	21
12	22	18	20	23	18	19	20

NS = Non-significant.

Table 5. Effect of calcium carbonate concretion on P availability (μg/g) during winter (rabi) 2003.

CCC (%)	Sampling interval (days after CCC application)						Mean
	15	30	45	60	75	90	
0	32NS	29NS	27NS	25NS	23NS	20NS	26NS
3	32	29	26	22	24	20	25
6	29	30	26	22	22	19	25
9	29	26	26	21	20	19	23
12	28	26	26	21	20	18	23

Ns = Non-significant

Similar results were obtained during kharif season and no significant decrease was observed in P availability to maize crop. However, higher P (25.0 μg/g during 2002 and 24.0 μg/g during 2003) was observed in control and lowest P (21.0 μg/g during 2002 and 22.0 μg/g during 2003) in treatment of 12 percent CCC (Table 6). Overall picture of P availability (Table 7) indicates that apparently CCC application had a negative effect but statistically the effect was non-significant. However, three years means for P indicated that P in soil decreased gradually (Table 7) but the difference between the treatments was non-significant and not reflected in crop yield.

Table 6. Effect of calcium carbonate concretion on P availability (μg/g) during summer (kharif) 2002 and 2003.

CCC (%)	Sampling interval (days after CCC application)					
	2002			2003		
	15	30	Mean	15	30	Mean
0	25NS	24NS	25NS	25NS	22NS	24NS
3	25	24	25	23	21	22
6	23	23	23	23	21	22
9	23	21	22	23	20	22
12	22	19	21	23	21	22

NS = Non-significant

Table 7. Summery of effect of calcium carbonate concretion (CCC) on the availability of P (μg/g) during winter (rabi) summer (kharif) 2001, 2002 and 2003.

Calcium, Carbonate, Concretions(%)	Sampling season						
	Rabi (winter)				Kharif (summer)		
	2001	2002	2003	Mean	2002	2003	Mean
0	27NS	24NS	26	25NS	25NS	23NS	24NS
3	26	22	25	24	25	22	24
6	24	21	25	23	23	22	23
9	23	21	23	22	22	22	22
12	22	20	23	22	21	22	21

NS = Non-significant

The results indicated that increasing CCC level did not reduce wheat grain and maize fodder yields and P availability during rabi (winter) and kharif (summer). A keen look on the results revealed that total quantity of $CaCO_3$ did not play much important role in affecting P availability as well as reduction in yield. Perhaps the volume of CCC may be important in this respect as has been reported by Javid and Rowell (8). They found that total quantity of CCC in soil was poorly correlated with P availability. Some studies have also shown poor correlation of P adsorption with total $CaCO_3$ (10) and surface area of $CaCO_3$ is considered to be more important than total amount (4). In present study CCC was certainly had much less surface area than its equivalent powder. Due to this reason P availability to crop was least affected.

CONCLUSION

There was no significant effect of CCC on the yield of any crop. The total amount of natural $CaCO_3$ concretions did not hamper the P availability to crops to a significant level.

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