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SOLUBILITY OF PHOSPHORUS AND SULPHUR IN TWO CALCAREOUS SOILS

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Solubility relationship of sulphur (S) and phosphorus (P) were evaluated in two calcareous soils. Balkasar (Udic Haplustall) and Shahdara (Typic Torrifluvcnt) soils amended with 0,25, 50 and 75 mg/k~~each of Sand P in all possible combination in triplicate according to completely randomized design were incubated at 25 ± 2° C. After four weeks of incubation period the amended soils were extracted with CaCI2 and NaHC03 for Sand P estimation. Application of Sand P had a significant (P <0.01) main and interactive affect on CaCI2 as well as NaHC03 extractable Sand P in the two soils. Influence of P application was more prominent than S on their extractable quantities in the two soils. Significant (P < OJl1) relationship between NaHC03-S(Y) and applied S(Xl) and P(X2) was Y = 14.85 + O.5Xl + 0.8X2 (R = 0.(7) in Balkasar soil and was Y = 15.95 + 0.53X1 + 0.073X2 (R = 0.(8) in Shahdara soil. Singificant (P < 0.05) relationship (R = 0.70) between NaIICC):j-S(Y) and CaCI2-SeX) was given by the equation: Y = - 5.7<)+ 2.11X. Significant relationship between NaHC03-P(Y) and applied P(Xl) and S(X2) was Y=O.17 + 0.97Xl + O.17X2 (R=0.98) in Balkasar soil and was Y=OJi7 + 0.93Xl + OJl4X2 (R=0.98) in Shahdara soil. Applied P mainly precipitated as Ca-phosphates in the two soils. Significant (P<O.OI) relationship (r=O.<JO)between NaIICOJ-f'(Y) and CaCI2-P(X) was given by the equation: Y =0.13 + 1.4lJX.

INTRODUCTION

For their growth, plants absorb sulphur and phosphorus from soil solution. They exist in an anionic from in soils and arc absorbed in this form by plants (Tisdale 1(85). Synergistic as well as antagonistic interaction between Sand P has been reported in different soil and plant situations (Singh, 1(88). They are involved in protein synthesis and are components of vital amino acids methionine, cystine and cysteine (Thompson *et al.,* 1(86). Synergistic relationship among Sand P applied to fodder sorghum also reduced a substance in plants fatal to livestock, hydrocyanic acid (Singh *et al.* 1(88).

Deficiency of P is more frequent than S in alkaline calcareous soils of arid and semi-arid regions. Phosphorus is, therefore, commonly applied to alleviate its deficiency. In acidic soils applied P can desorb S from soil colloids and is held more strongly by soils than sulphate (Tisdall *et al. 1(85).* However, interactive effect of Sand P on their availablity in alkaline calcareous soils has rarely been reported. Sulphur application is not common for crop production on arid soils. But application of S to an alkaline calcareous soil increased P availability by lowering soil pH (Clement, 1(78). Tisdale *et al.,* (1985) have discussed a eo-precipitation of Sand P by CaC03 in some temperate region soils. Major reserves of Sand P in arid region calcareous soils are organic sulphur and insoluble calcium phosphates, respectively (Nabi *et al.,* 1990; Rahrnatullah, 1(92). In light of the studies conducted on acid soils of temperate region it is difficult to extrapolate the interactive effect of Sand P application on their availability in calcareous soils. It has also not been studied extensively in arid region soils. For the present investigation two calcareous soils were, therefore, amended with different levels of Sand P to study their level in soil solution in relation to their NaHC03 extractable status and solubility relationships of P.

MATERIALS AND METHODS

Bulk surface (0.15 cm) samples collected for Balkasar series (Udic llaplustalf) and Shahdara series (Typic Torrifluvcnt) were air dried and ground to pass through a 2 mm sieve. They were characterized for some pertinent properties reported in Table 1. Twenty g portion of each of the two soils taken in conical flasks received 0, 25, 50 and 75 mg of Sand P in all possible combinations. Sulphur and P were added in solution as K2S04 and KH2P04, respectively. The treatments were imposed in triplicate according to completely randomized design (Steel and Torril, 1(80). After Sand P application soil in each flask was shaken for one hour and incubated at 25 ± 2° C. Alternate wetting and drying cycles were repeated twice for the treated soils. After three weeks incubation four g of soil sampled from each container was extracted with 40 ml of 0.01 M CaCl2 by shaking for two hours on a reciprocating shaker. Clear filtrate from Ca Ch extraction was analyzcd for pH, EC, Ca, Mg, P and S. Ion activities of P in CaCI2 extracts were calculated using Davies equation for estimating' activity coefficients (Davies, 19(2). Electrical conductivity was used as an estimate of ionic strength (Griffin and Jurinak, 1(73). The phosphate solubility lines for different forms were used as shown by Lindsay (1979). Sample from each container was also analyzcd for 0.5 M NaHC03-extractable (Watanabe and Olsan, 1(65) P and S. Sulphur in the two type of extracts was estimated by BaC12 turbidimetric method (Verma *et al.,* 1(77). Phosphorus was determined by vanadomolyblate blue color method.

RESULTS AND DISCUSSION

Sulphur availability: Balkasar and Shahdara soils had initially NaHC03 cxtructublc-S less than its critical level of 22 mg S/kg soil, reported for wheat cultivation on similar alluvial soils of Indian Punjab (Takkar, 19HH). Application of Sand P, therefore, had a significant (P < n.01) main and interactive effect on CaCI2 as well as NallC03 extractable S in the two soils. Relationship of S extracted by NallCCh (Y) to S (Xj) and P (X2) application depicted in (Fig. 1) in Balkasar soil was Y = 14.85 + O.5Xj + 0.8X2 (R = 0.(7) and was Y = 15.95 + 0,53Xj + 0.73X2 (R=0.91) in Shahdara soil. The two soils responded similarly to initial application of 25 mg/kg of either S or P. But increase in NaHC03 extractable S with subsequent addition of Sand P had been more regular in Balkasar than in Shahdara soil. The two soils responded differently to Sand P amendments. Application of P had a more pronounced influence on NaHC03 extractable S in the two soils. While competing for the same reaction sites phosphate is held more strongly than sulphate and hence sulphate is dcsorbcd easily from soil constituents (Barrow, 1970; Bohn *et al.* 1(86). Influence of P application on NaHC03 extractable S was 23% higher in Balkasar than in

Shahdara soil. But shahdara soil had a more NaHC03 extractable S than Balkasar soil (Fig. 2). While CaCh extractable S was significantly (P<O.Ol) higher in Balkasar soil than in Shahdara soils. Shahdara soil has more CaC03 (Table 1). A eo-precipitation of S with CaC03 in soils had been discussed (P.296) by Tisdale *et al.,* (1985). Relatively coarser texture in Balkasar soil may also has allowed more S in soil solution ($CaCl_2$ extractable S) than in Shahdara soil. A significant ($P < 0.05$) correlation between CaCh extractable Sand NaHC03 extractable S was calculated using average values of S concentration found for the two soils and for four levels of each of Sand P application (Fig. 2).

Phosphorus availability: Balkasar and Shahdara soils, used in this study, were initially deficient in P (Table 1).

Tahle 1. Selected phy~il'(l-l'hl'lllil':I1 propl'rtil's of the two soils.

Property	Unit	Soils	
		IIalkasar (Udic Ilapluslalf)	ShahJara (Typic TorriOuvenl)
Sand	%	69.7	22.5
Silt	%	18.1	69.4
Clay	%	12.1	8.1
Texlure	%	Sandy loam	Silt loam
pH (1:1)	-	7.6	8.0
EC (1:1)	dS/m	0.24	0.33
CaC03	%	2.9	4.6
Organic matter	%	0.1	0.1
NaIIC03-P	mg/kg	0,53	0.90
NaHC03-S	mg/kg	16,43	21,97

Application of Sand P to these two soils, therefore, had a significant ($P < 0.01$) main and interactive effect on CaCh as well as NaHC03 extractable P in the two soils. Relationship of P extracted by NaHC(h (Y) to P(XI) and S (X2) application illustrated in Fig. 3 in Balkasar soil was Y=O.17 + 0.97XI + 0.17X2 (R=0.98) and was Y=0.67 + 0.93 Xj + 0.04X2 (R = 0.98) in Shahdara soil. Phosphorus application had a more prominent influence than S application on NaHC03 extractable P in the two soils. Influence of Sand P soil amendment was more prominent in Balkasar soil than in Shahdara soils. Nevertheless, a small fraction of added P was extractable either with NaHC03 or CaCh in the two soils. Phosphorus precipitates predominantly as calcium phosphates in calcareous soils (Ruhrnatullah *et al.* 1992., Tisdale *et al.,* llJ85). Solubility relationships of P according to Lindsay (1979) indicated difrerences in precipitation products in the two soils. Applied P precipitated probably as f3-tricalcium phsophate and hydroxyapatite in Balkasar soil while in Shahdara soil it mainly precipitated as octo-calcium phosphate.

Phosphorus extracted by CaCh as well as by NallC<h was maximum in Shahdara soil. A significant (P<OJl1) linear correlation between CaClz extractable P and NaHC03 extractable P was calculated using average values of P found for the two soils and for four levels of each of Sand P application (Fig. 4).

CONCLUSIONS

Application of Sand P significantly ($P < 0.01$) increased their CaClz as well as NaHC03 extractable quantities in the two soils. Influence of P application was more prominent than S addition on Sand P extracted from the two soils. Applied P mainly precipitated as calcium phosphate in the two soils.

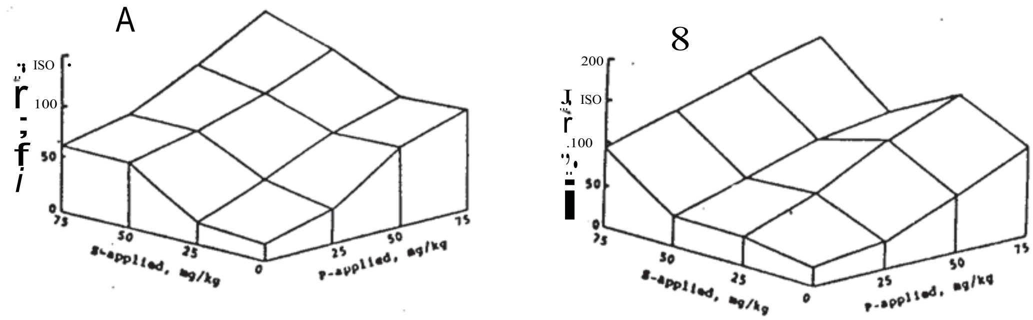


Fig. 1. Extraction of sulphur by O.5M $NaHCO_3$ from Balkasar (A) and Shahdra (B) soils treated with Sand P.

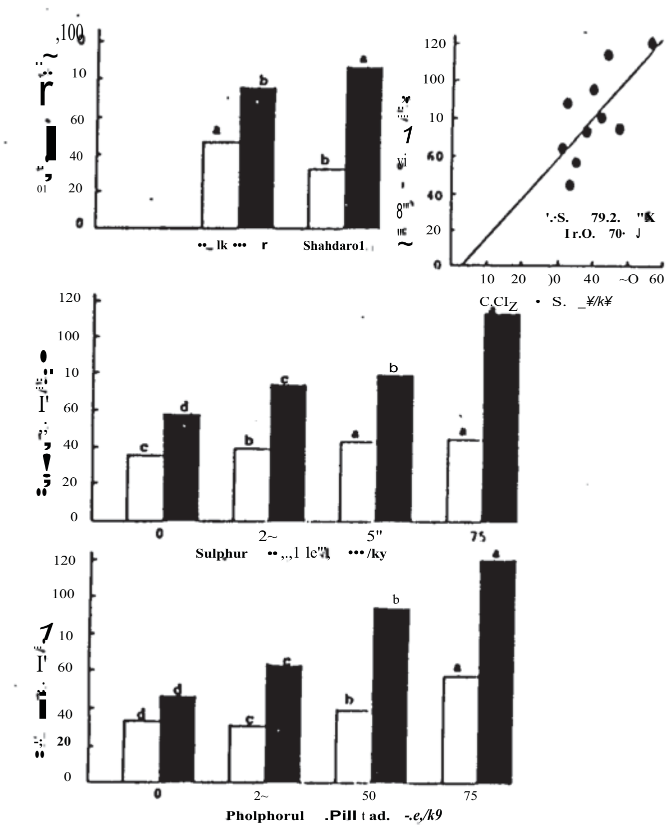


Fig. 2. Status and relationship among sulphur extracted by $CaCl_2$ 0 and $NaHCO_3$ • from Balkasar and Shahdara soils treated with Sand P.

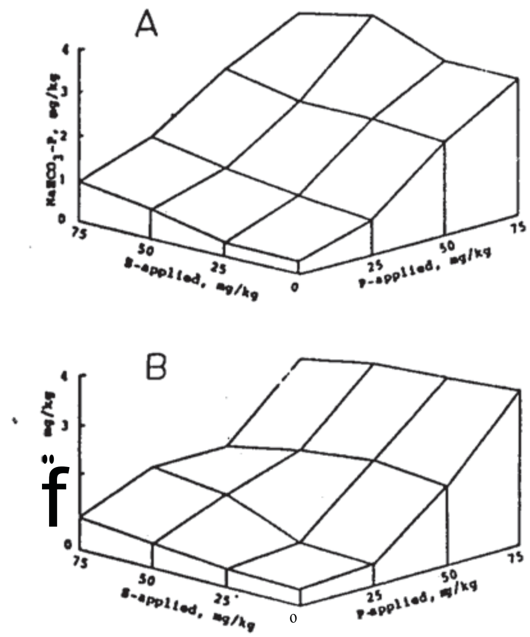


Fig. 3. Phosphorus extracted by O.5M NaHC03 from Balkasar (A) and Shahdra (B) soils treated with S and P.

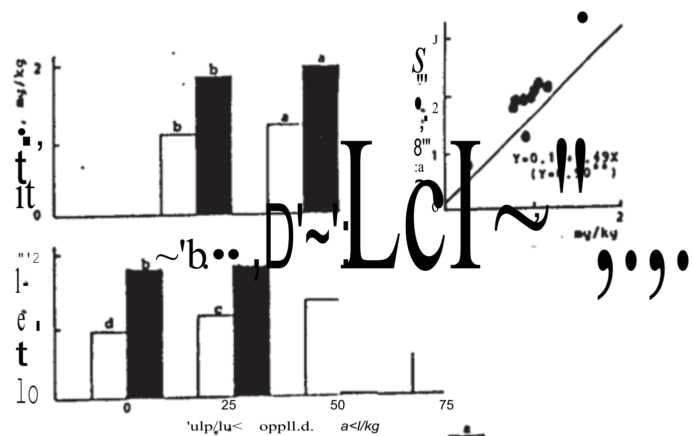


Fig. 4. Status and relationship among phosphorus extracted by CaCl2 and NaHCO3 from Balkasar and Shahdara soils treated with Sand P.

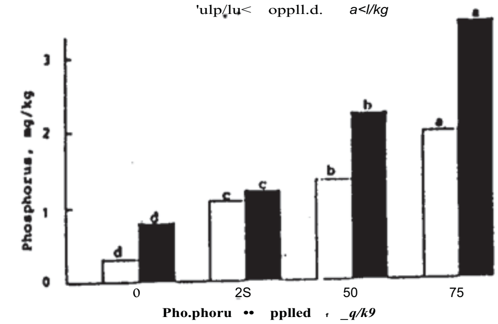
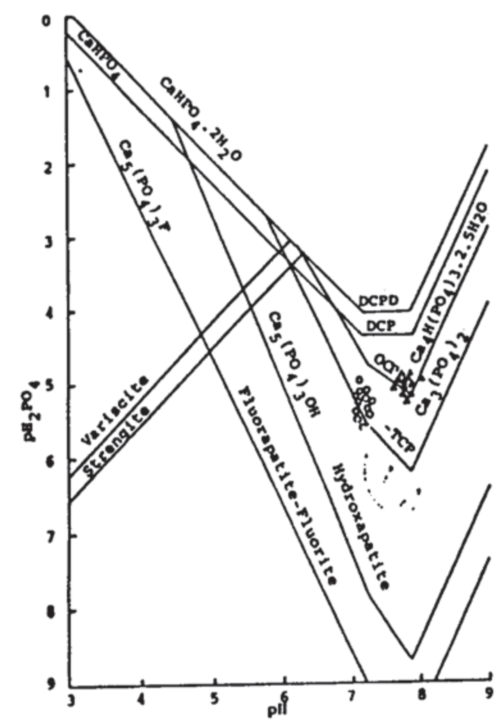


Fig. 5. Phosphorus solubility in Balkasar (0) and Shahdra (6) soils treated with Sand P.



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