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Effect of temperature on phosphate adsorption by soils

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Abstract
Phosphorus is one of the most important elements whose sorption by soil depends upon many factors like anions, pH, ionic strength, incubation period and temperature. In this study effect of temperature on Phosphorus sorption was determined in some alluvial soils of Punjab. Phosphorus adsorption was significantly influence by temperature. Some soils sample showed exothermic nature of adsorption while some showed endothermic behaviour. In one of the soil sample, mixed nature was observed where at low equilibrium concentration, adsorption increased with temperature while at high equilibrium concentration, adorption decreased with temperature.

Keywords: Temperature, phosphate adsorption, soils

Introduction
Phosphorous is one of the most important nutrients for agriculture production. The availability of P is very less in most of the soil due to fixation. When P fertilizers are applied to the soil, the phosphate ions are adsorbed on to the soil surface because of its high affinity for mineral surfaces and thus result in decrease of its availability to crops. Phosphate adsorption by soil is governed by many factors such as total phosphorous concentration, nature and amount of clay, different anions, soil pH, ionic strength, time of reaction and temperature. In the present study, the effect of temperature on phosphate adsorption by some alluvial soils of Punjab has been determined.

Experimental details
A Stock solution of Phosphorous (50 ppm) was prepared by dissolving 0.2194 g of KH_2PO_4 in distilled water and making the final volume one litre on adding distilled water. Asolution of 0.02M sodium borate was obtained by dissolving 7.63 g $Na_2(BO_4)_4$ in distilled water and final volume was made one litre. One gram soil sample was taken in each of the nine reagent bottles. The aliquots of 0, 3, 4, 5, 6, 7, 8, 9 and 10 ml of stock solution of P (50 ppm) were added in different bottles and then volume of 25 ml of 0.02M sodium borate was added. The contents were mixed and final volume was made 50 ml in each case by adding distilled water. The reagent bottles with contents were then incubated at the desired temperature (25 ^{O}C and 35 ^{O}C) with frequent shaking for 48 hours. After that different solutions were centrifuged and the amount of P in the extract was determined spectrophotometrically using Ascorbic Acid method.

Results and Discussion
It is well known fact that adsorption process is influenced to a greater extent by a change in temperature as the process is exothermic in nature. The effect of temperature on Phosphate adsorption by soils is therefore an impotent study. The data obtained for the adsorption of phosphate on different soils in the presence of 0.01M Na_3BO_4 at 25^0C and 35^0C are given in Table 1 and plotted in figure 1

A perusal of the data reveals the effect of temperature on various soils is different in case of Jassipawali, Jodhpur Romana, Fatehpur and Sadhu soils. The amount adsorbed decreases with temperature.

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The observation is in accordance with the exothermic nature of adsorption process. Barrow and Shaw (1975) [5] while studying the slow reaction between phosphates and soils at a range of temperatures observed that high temperature favoured high concentration of solutions that is, the adsorption was exothermic. In case of other soils the amount phosphate adsorbed increases with increase of temperature. This observation does not coincide with the exothermic nature of the adsorption process. It is difficult to assign reasons for such behavior. Probably, this type of behavior exhibited by these soils may be attributed to some structural changes on the soil surface at high temperature resulting in some additional adsorption sites for phosphate The Gahribhagi soil shows results of mixed nature. At lower equilibrium concentration adsorption increases with temperature but at higher equilibrium concentration, the amount adsorbed decreases with temperature. The behaviour of this soil suggests that the nature of soil surface may be modified with change in temperature. Mehadi and Taylor (1988) [6] also observed that P adsorption increases at high temperature indicating P adsorption to be an endothermic process and suggests that P was held more tightly to the soil surface at high temperature.

Table 1: Effect of Temperature on Phosphate Adsorption by Soil in the Presence of $Na_2B_4O_7$

Gahribhagi soil				
	25ºC		**35ºC**	
Initial Conc. Of P	**Eqbm.conc. Of P**	**amount of P adsorped**	**Eqbm.conc. Of P**	**amount of P adsorped**
(u mole / l)	**(u mole / l)**	**u mole P/ g soil**	**(u mole / l)**	**u mole P/ g soil**
96.77	72.26	1.22	67.09	1.48
129.03	99.35	1.48	96.77	1.61
161.29	127.74	1.68	127.74	1.68
193.55	157.42	1.81	149.68	2.19
225.81	176.77	2.45	171.61	2.71
258.06	193.55	3.22	198.71	2.97
290.32	211.61	3.93	223.22	3.35
322.58	230.97	4.58	247.74	3.74

Jassipauwali soil				
	25ºC		**35ºC**	
Initial Conc. Of P	**Eqbm.conc. Of P**	**amount of P adsorped**	**Eqbm.conc. Of P**	**amount of P adsorped**
(u mole / l)	**(u mole / l)**	**u mole P/ g soil**	**(u mole / l)**	**u mole P/ g soil**
96.77	74.83	1.09	80	0.84
129.03	103.22	1.29	110.97	0.9
161.29	134.19	1.35	141.93	0.97
193.55	157.42	1.81	171.61	1.09
225.81	176.77	2.45	198.71	1.35
258.06	193.55	3.22	223.22	1.74
290.32	211.61	3.93	247.74	2.13
322.58	230.97	4.58	270.96	2.58

Jodhpur Ramana Soil				
	25 ºC		**35 ºC**	
Initial Conc. Of P	Eqbm.conc. Of P	amount of P adsorped	Eqbm.conc. Of P	amount of P adsorped
(u mole / l)	(u mole / l)	u mole P/ g soil	(u mole / l)	u mole P/ g soil
96.77	72.26	1.22	76.13	1.03
129.03	96.77	1.61	105.81	1.16
161.29	127.74	1.68	135.48	1.29
193.55	145.81	2.39	161.29	1.61
225.81	166.45	2.97	187.09	1.93
258.06	187.09	3.55	211.61	2.32
290.32	205.16	4.26	238.71	2.58
322.58	223.22	4.97	258.06	3.22

Fatehpur Soil				
	25 ºC		**35 ºC**	
Initial Conc. Of P	Eqbm.conc. Of P	amount of P adsorped	Eqbm.conc. Of P	amount of P adsorped
(u mole / l)	(u mole / l)	u mole P/ g soil	(u mole / l)	u mole P/ g soil
96.77	68.39	1.42	72.26	1.22
129.03	94.19	1.74	103.22	1.29
161.29	123.87	1.87	130.32	1.55
193.55	148.38	2.25	157.42	1.81
225.81	171.61	2.71	183.22	2.12
258.06	187.09	3.55	211.61	2.32
290.32	205.16	4.26	238.71	2.58
322.58	223.22	4.97	270.97	2.58

Kanjli Soil

	25 ºC		35 ºC	
Initial Conc. Of P	**Eqbm.conc. Of P**	**amount of P adsorped**	**Eqbm.conc. Of P**	**amount of P adsorped**
(u mole / l)	**(u mole / l)**	**u mole P/ g soil**	**(u mole / l)**	**u mole P/ g soil**
96.77	72.26	1.22	64.51	1.61
129.03	99.35	1.48	91.61	1.87
161.29	127.74	1.68	121.29	2
193.55	157.42	1.81	145.8	2.39
225.81	176.77	2.45	167.74	2.9
258.06	198.71	2.97	183.22	3.74
290.32	216.77	3.68	211.61	3.93
322.58	238.71	4.19	230.96	4.58

Lodhowal soil				
	25 ºC		**35 ºC**	
Initial Conc. Of P	**Eqbm.conc. Of P**	**amount of P adsorped**	**Eqbm.conc. Of P**	**amount of P adsorped**
(u mole / l)	**(u mole / l)**	**u mole P/ g soil**	**(u mole / l)**	**u mole P/ g soil**
96.77	61.93	1.74	58.06	1.93
129.03	89.03	2	83.38	2.25
161.29	117.42	2.19	110.96	2.51
193.55	145.81	2.39	138.06	2.77
225.81	167.74	2.9	158.71	3.35
258.06	183.22	3.74	176.77	4.06
290.32	198.71	4.58	193.54	4.84
322.58	216.77	5.29	211.61	5.54

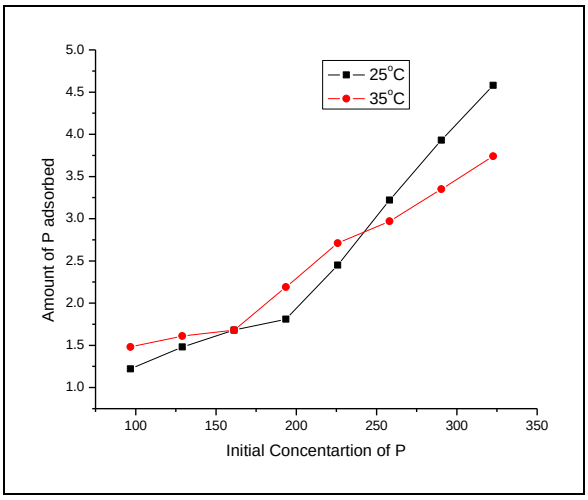
Nabha Soil				
	25 ºC		**35 ºC**	
Initial Conc. Of P	**Eqbm.conc. Of P**	**amount of P adsorped**	**Eqbm.conc. Of P**	**amount of P adsorped**
(u mole / l)	**(u mole / l)**	**u mole P/ g soil**	**(u mole / l)**	**u mole P/ g soil**
96.77	55.48	2.06	52.9	2.19
129.03	78.71	2.52	76.13	2.64
161.29	105.8	2.77	103.22	2.9
193.55	134.19	2.97	127.74	3.29
225.81	157.42	3.42	154.84	3.54
258.06	176.77	4.06	167.74	4.51
290.32	193.55	4.84	187.09	5.16
322.58	211.61	5.55	205.16	5.81

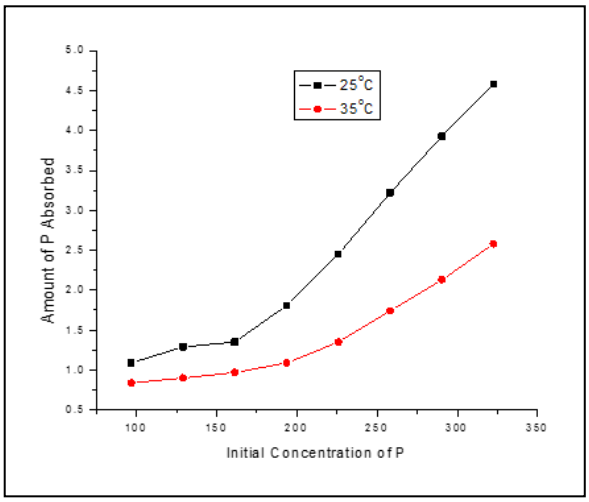
Sadhu Soil				
	25 ºC		**35 ºC**	
Initial Conc. Of P	**Eqbm.conc. Of P**	**amount of P adsorped**	**Eqbm.conc. Of P**	**amount of P adsorped**
(u mole / l)	**(u mole / l)**	**u mole P/ g soil**	**(u mole / l)**	**u mole P/ g soil**
96.77	68.39	1.42	72.26	1.22
129.03	96.77	1.61	103.22	1.29
161.29	127.74	1.68	130.32	1.55
193.55	145.81	2.39	157.42	1.81
225.81	171.61	2.71	183.22	2.12
258.06	193.54	3.22	211.61	2.32
290.32	211.61	3.93	238.71	2.58
322.58	230.97	4.58	270.97	2.58

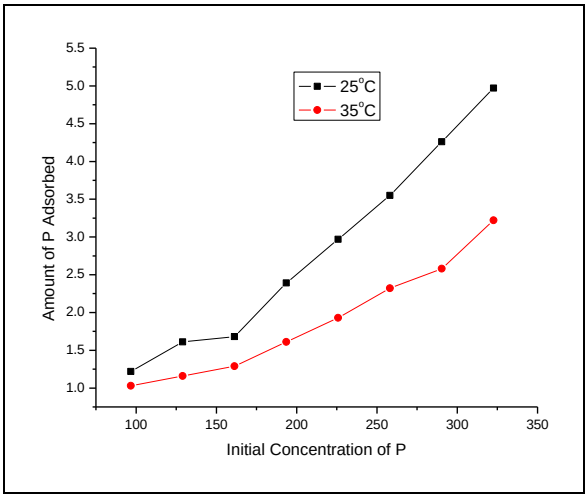
Chamror Soil				
	25 ºC		**35 ºC**	
Iinitial Conc. Of P	**Eqbm.conc. Of P**	**amount of P adsorped**	**Eqbm.conc. Of P**	**amount of P adsorped**
(u mole / l)	**(u mole / l)**	**u mole P/ g soil**	**(u mole / l)**	**u mole P/ g soil**
96.77	68.39	1.42	61.93	1.74
129.03	94.19	1.74	83.87	2.26
161.29	123.87	1.87	110.96	2.51
193.55	148.39	2.25	141.93	2.58
225.81	171.61	2.71	161.29	3.22
258.06	187.09	3.35	183.22	3.74
290.32	211.61	3.93	205.16	4.25
322.58	230.97	4.58	223.22	4.96

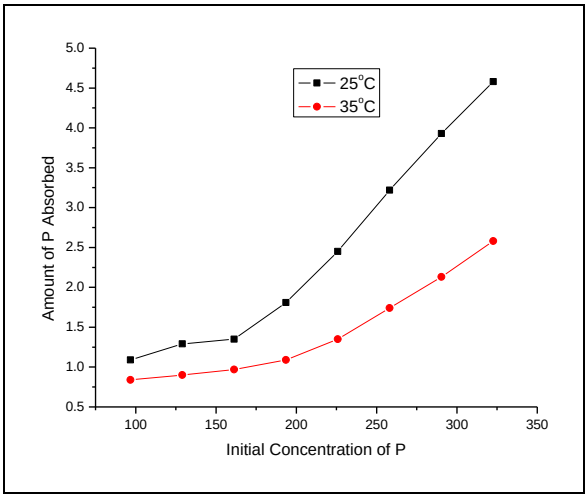
Dhar Soil

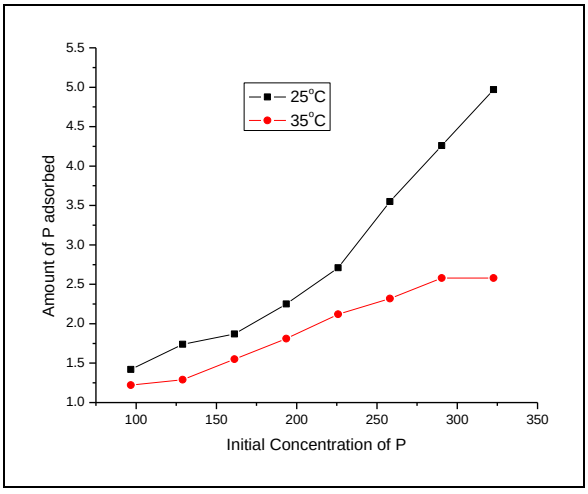
	25 ºC		35 ºC	
Iinitial Conc. Of P	**Eqbm.conc. Of P**	**amount of P adsorped**	**Eqbm.conc. Of P**	**amount of P adsorped**
(u mole / l)	**(u mole / l)**	**u mole P/ g soil**	**(u mole / l)**	**u mole P/ g soil**
96.77	61.93	1.74	46.45	2.51
129.03	89.03	2	76.13	2.64
161.29	117.42	2.19	103.22	2.9
193.55	145.81	2.39	135.48	2.9
225.81	167.74	2.9	154.83	3.54
258.06	187.09	3.55	171.61	4.32
290.32	205.16	4.26	187.09	5.16
322.58	223.22	4.97	211.61	5.54

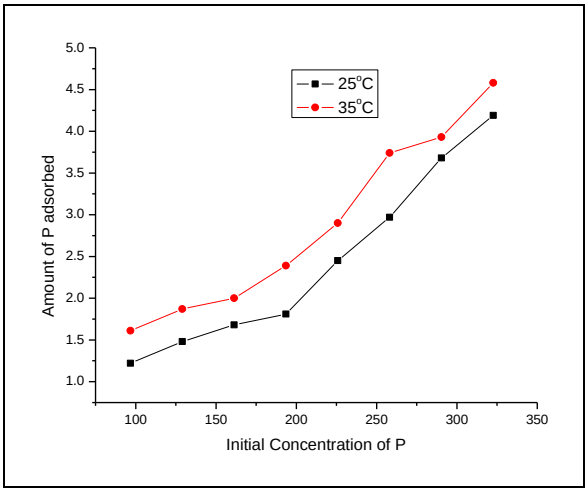












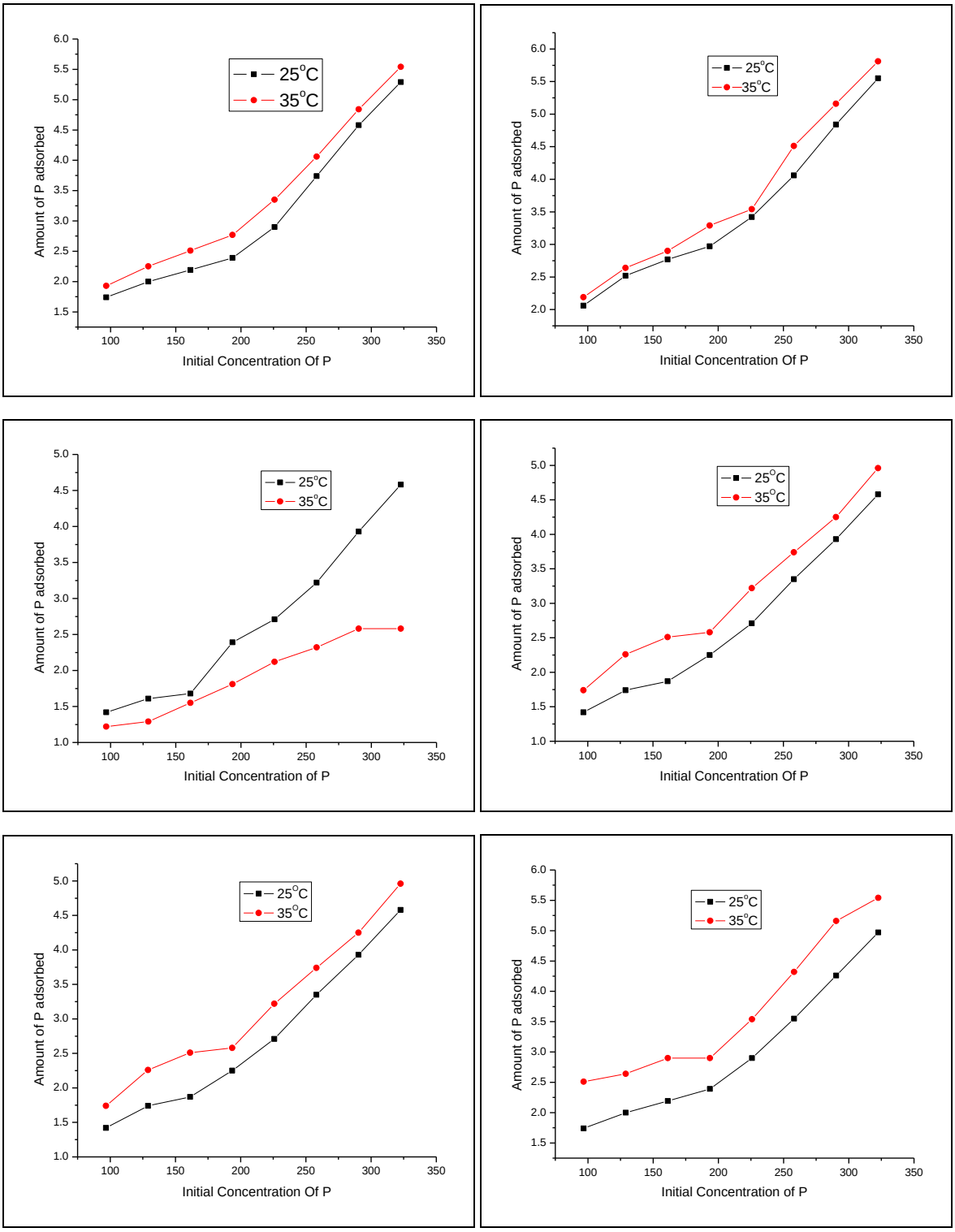


Fig 1: Effect of Temperature on Phosphate Adsorption by Soil in the Presence of $Na_2B_4O_7$

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