Supplementary Material

Table S1 The original and coded levels of the input variable**.**

Factor	Name	Units	Minimum	Coded Low	Mean	Coded High	Maximum
A	pH	-	3	5	7	9	11
B	P concentration	mg/L	50	125	200	275	350
C	Time	min	10	35	60	85	110

Table S2 Experimental design for P removal.

Run	pH	P Concentration (mg/L)	Time (min)	q_e (mg/g)
1	7	125	60	102.6
2	7	200	60	112.23
3	3	50	10	15.39
4	3	350	110	56.25
5	7	200	60	110.3
6	11	50	10	34.63
7	7	275	60	118
8	5	200	60	94.14
9	7	200	60	110.3
10	9	200	60	104.15
11	11	350	110	67.5
12	7	200	60	110.82
13	7	200	60	109.41
14	11	350	10	49.3
15	11	50	110	50.23
16	7	200	85	116.72
17	7	200	35	101.58
18	3	350	10	34.03
19	7	200	60	114.02
20	3	50	110	27.73

Table S3 ANOVA for central composite design.

Source	Sum of Squares	df	Mean Square	F-value	p-value
Model	23890.89	9.00	2654.54	454.40	< 0.0001
A-pH	631.45	1.00	631.45	108.09	< 0.0001
B-Phosphate	886.38	1.00	886.38	151.73	< 0.0001
C-Time	678.23	1.00	678.23	116.10	< 0.0001
AB	28.96	1.00	28.96	4.96	0.0502
AC	0.07	1.00	0.07	0.01	0.9137
BC	19.47	1.00	19.47	3.33	0.0979
A^2	493.69	1.00	493.69	84.51	< 0.0001
B^2	8.67	1.00	8.67	1.48	0.2511
C^2	24.32	1.00	24.32	4.16	0.0686
Residual	58.42	10.00	5.84		
Lack of Fit	44.42	5.00	8.88	3.17	0.1154
Pure Error	14.00	5.00	2.80		
Cor Total	23949.31	19.00			

Table S4 Isotherm study of P adsorption on VB800@D-20.

Langmuir isotherm				**Freundlich isotherm**			**D-R isotherm**			
K_L (L/mg)	**q_m (mg/g)**	**R_L**	**R^2**	**K_F (L/g)**	**n**	**R^2**	**K_{DR} (mol2/kJ^2)**	**q_{DR} (mg/g)**	**E (kJ/mol)**	**R^2**
0.0116	178.57	0.25	0.9992	6.53	1.72	0.9901	0.0044	242.25	10.66	0.9882

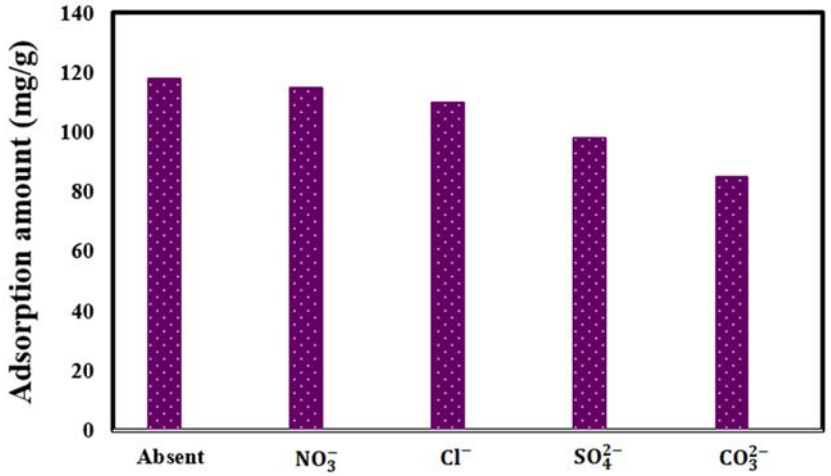

Fig. S1. Interfering ions effects on P ion adsorption performance of VB800@D-20 (P concentration = 250 mg/L, contact time = 90 min, applied VBs = 500 mg/L, pH = 7).

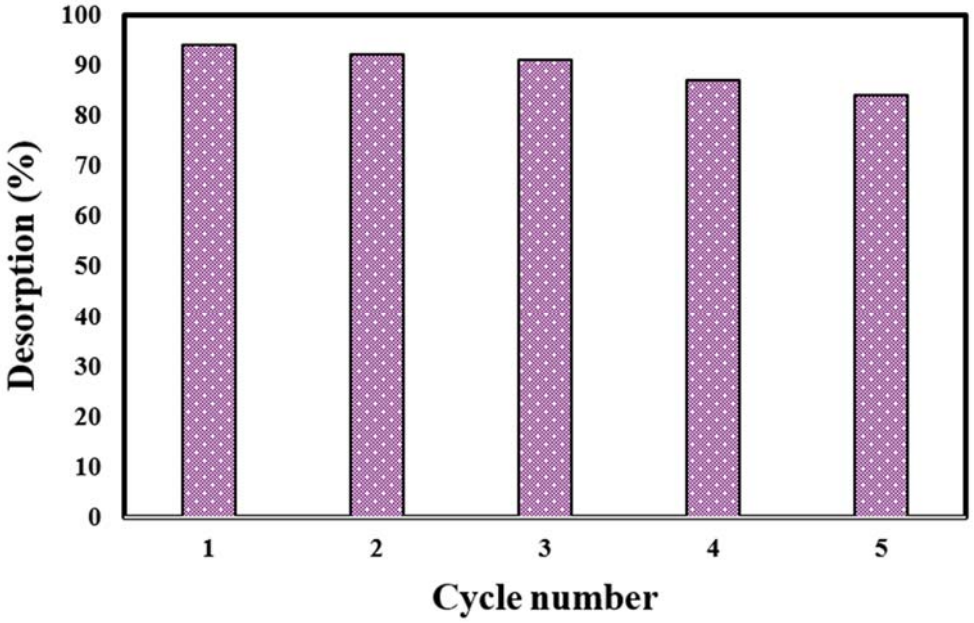

Fig. S2. Cycles of P adsorption/desorption onto VB800@D-20.

Table S5 Statistical analysis of VB800@D-20/P effect on growth of Setaria Viridis; comparison of height and weight with control condition.

Item		Number of Sample	Mean	SD	Min	Max
Height	Control	10	12.29	1.46	10.08	14.62
(cm)	Biochar Added	10	18.31	2.12	16.18	22.59
Dry Weight	Control	10	3.68	0.44	3.02	4.39
(g)	Biochar Added	10	6.15	0.71	5.43	7.59