Effects of Graphene on Soil Water-Retention Curve, van Genuchten Parameters, and Soil Pore Size Distribution—A Comparison with Traditional Soil Conditioners

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Supplementary Material

Table S1. Mean±St.dev. values of different porosity attributes, van Genuchten parameters and ρ_b of the three studied soils A, B, C under the effects of different doses of the four soil conditioners (Compost, Biochar, Zeolite, and Graphene) together with LSD multiple range tests at 0.05 level and one-way ANOVA results (F-ratio, P-value).

Parameter	Drainage porosity	Storage porosity	Residual porosity	Total porosity (measured θ_s)	a	n	θ_r	$\lvert S_i \rvert$	R^{2**}	ρ_b
	($cm^3\ cm^{-3}$)	($cm^3\ cm^{-3}$)	($cm^3\ cm^{-3}$)	($cm^3\ cm^{-3}$)	(cm^{-1})	-	($cm^3\ cm^{-3}$)	(cm^{-1})	-	($g\ cm^{-3}$)
Soil type					**Soil A**					
Control	0.092±0.030d	0.334±0.008ab	0.094±0.022e	0.521±0.020e	0.007±0.004d	1.461±0.151ab	0.023±0.028bc	0.00083±0.000e	0.994	1.535±0.031c
Compost 5%	0.102±0.006cd	0.338±0.011a	0.122±0.005cd	0.563±0.011cd	0.013±0.005bcd	1.459±0.383ab	0.037±0.064bc	0.00130±9.243de	0.984	1.453±0.016de
Compost 10%	0.182±0.043a	0.293±0.008c	0.150±0.001a	0.626±0.038ab	0.026±0.009a	1.421±0.186ab	0.081±0.071ab	0.00273±0.000a	0.998	1.434±0.060e
Biochar 5%	0.129±0.027bcd	0.342±0.018a	0.129±0.003bc	0.601±0.041bc	0.008±0.002cd	1.655±0.093a	0.096±0.018ab	0.00130±0.000de	0.994	1.510±0.095cd
Biochar 10%	0.191±0.045a	0.304±0.038bc	0.132±0.010abc	0.627±0.007ab	0.019±0.003ab	1.587±0.090a	0.130±0.019a	0.00262±0.000ab	0.997	1.387±0.009ef
Zeolites 5%	0.145±0.004abc	0.294±0.021c	0.105±0.008de	0.544±0.013de	0.019±0.003ab	1.355±0.028ab	0.030±0.007bc	0.00181±0.000bcd	0.998	1.613±0.018b
Zeolites 10%	0.132±0.006bcd	0.281±0.002c	0.143±0.005ab	0.557±0.006de	0.020±0.001ab	1.253±0.004b	0±0c	0.00166±0.000cd	0.994	1.719±0.004a
Graphene 0.5%	0.143±0.034abc	0.342±0.019a	0.121±0.017cd	0.606±0.006b	0.015±0.006bcd	1.571±0.208a	0.095±0.066ab	0.00193±0.000abcd	0.990	1.339±0.018f
Graphene 1%	0.158±0.011ab	0.349±0.017a	0.146±0.011ab	0.653±0.019a	0.016±0.007abc	1.564±0.204a	0.126±0.046a	0.00212±0.000abc	0.995	1.201±0.017g
F-ratio	4.10	5.67	7.91	11.77	3.59	1.41	3.49	5.25	-	41.58
P-value	<0.05	<0.05	<0.05	<0.05	<0.05	0.257	<0.05	<0.05	-	<0.05
Soil type					**Soil B**					
Control	0.125±0.053bcd	0.265±0.038c	0.181±0.073ab	0.573±0.003d	0.020±0.022a	1.602±0.679a	0.086±0.148a	0.00156±0.001ab	0.966	1.260±0.042ab
Compost 5%	0.171±0.019a	0.355±0.036ab	0.134±0.005b	0.661±0.027bc	0.015±0.002a	1.541±0.055a	0.104±0.026a	0.00220±0.000ab	0.991	1.176±0.158b
Compost 10%	0.126±0.023bcd	0.361±0.021a	0.192±0.013a	0.680±0.013b	0.015±0.004a	1.415±0.097a	0.124±0.021a	0.00168±0.000ab	0.993	1.176±0.010b
Biochar 5%	0.117±0.018d	0.331±0.023ab	0.196±0.012a	0.645±0.007c	0.010±0.003a	1.525±0.535a	0.071±0.124a	0.00123±0.000b	0.985	1.146±0.007bc
Biochar 10%	0.120±0.017cd	0.328±0.022abc	0.199±0.011a	0.648±0.005bc	0.011±0.005a	1.540±0.575a	0.073±0.126a	0.00133±0.000b	0.989	1.161±0.048bc
Zeolites 5%	0.091±0.001de	0.344±0.022ab	0.206±0.005a	0.642±0.026c	0.011±0.004a	1.309±0.094a	0.072±0.082a	0.00104±0.000b	0.992	1.320±0.080a
Zeolites 10%	0.064±0.012e	0.315±0.056abc	0.207±0.038a	0.587±0.009d	0.009±0.004a	1.489±0.079a	0.163±0.045a	0.00083±0.000b	0.991	1.315±0.015a
Graphene 0.5%	0.165±0.025ab	0.379±0.058a	0.171±0.001ab	0.716±0.032a	0.030±0.019a	1.306±0.081a	0.065±0.023a	0.00300±0.001a	0.989	1.051±0.051c
Graphene 1%	0.162±0.014abc	0.295±0.032bc	0.222±0.029a	0.681±0.016b	0.028±0.018a	1.518±0.347a	0.149±0.130a	0.00284±0.001a	0.984	0.865±0.046d
F-ratio	6.17	2.63	2.12	17.15	1.21	0.24	0.45	2.45	-	13.02
P-value	<0.05	<0.05	0.088	<0.05	0.346	0.976	0.877	0.054	-	<0.05
Soil type					**Soil C**					
Control	0.156±0.048de	0.317±0.039ab	0.233±0.003bcd	0.707±0.009c	0.023±0.011c	1.307±0.140a	0.097±0.099ab	0.00222±0.000c	0.985	0.948±0.013b
Compost 5%	0.168±0.036d	0.329±0.039a	0.245±0.012bcd	0.743±0.016b	0.016±0.003c	1.234±0.047ab	0.032±0.056bc	0.00156±0.000c	0.965	0.911±0.013c
Compost 10%	0.239±0.028c	0.269±0.032bc	0.262±0.003bc	0.771±0.009a	0.067±0.032c	1.148±0.002bc	0±0c	0.00514±0.002bc	0.969	0.883±0.035cd
Biochar 5%	0.306±0.009ab	0.222±0.005cd	0.229±0.008cd	0.759±0.009ab	0.244±0.115b	1.141±0.019bc	0±0c	0.01718±0.006b	0.978	0.849±0.029d
Biochar 10%	0.279±0.014bc	0.194±0.067d	0.305±0.049a	0.779±0.009a	0.168±0.089ab	1.109±0.054c	0±0c	0.00957±0.006bc	0.980	0.956±0.006b
Zeolites 5%	0.112±0.011e	0.332±0.026a	0.262±0.008bc	0.708±0.021c	0.008±0.001c	1.199±0.004bc	0±0c	0.00073±8.908c	0.973	1.040±0.029a
Zeolites 10%	0.129±0.008de	0.294±0.010ab	0.267±0.006b	0.690±0.016c	0.010±0.001c	1.304±0.063a	0.118±0.046a	0.00094±0.000c	0.965	1.009±0.008a
Graphene 0.5%	0.321±0.020ab	0.233±0.003cd	0.224±0.009d	0.780±0.011a	0.159±0.041bc	1.159±0.003bc	0±0c	0.01302±0.003bc	0.976	0.796±0.010e
Graphene 1%	0.349±0.021a	0.213±0.010d	0.219±0.027d	0.782±0.015a	0.489±0.245a	1.136±0.009bc	0±0c	0.03600±0.019a	0.976	0.731±0.010f
F-ratio	38.26	7.95	5.54	20.53	8.07	4.92	3.94	7.64	-	71.50
P-value	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05

Different letters indicate statistically significant differences at 0.05 level between treatments of each soil for each parameter based on LSD.
**Mean R^2 of the three fitted van Genuchten replicate curves.