

Supplementary Material: Coupled Effects of Reduced Chemical Fertilization and Biochar Supplementation on Availability and Transformations of Nitrogen and Phosphorus in Vegetable Farmland Soil: An In Situ Study in Southern China

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Table S1. Analytical methods used to determine the main physicochemical properties of the vegetable farmland soil and palm silk biochar (PSB) used in the present study.

Property	Method	Description
Specific surface area	BET-N ₂ adsorption method	A Micromeritics ASAP 2020 automated system using N ₂ as the adsorbate at -196°C in a relative vapor pressure of 0.025–0.3 after degastation at 105°C for 2 h
pH _{water}	Potentiometry	A Sartorius PB-10 pH meter equipped with a Sartorius pH/ATC electrode (Göttingen, Germany) after stirring at a 1:2.5 soil-to-water ratio (<i>w/v</i>) or a 1:10 PSB-to-water ratio
Cation exchange capacity	Ammonium acetate method	Extraction with 1 mol L ⁻¹ NH ₄ OAc (pH 7.0)
Total organic C	Volumetry	Titration with 0.2 mol L ⁻¹ FeSO ₄ after K ₂ Cr ₂ O ₇ -H ₂ SO ₄ oxidation
Total N	Kjeldahl method	Steam distillation of NH ₃ yielded after digestion with H ₂ SO ₄ and catalyst mixture (K ₂ SO ₄ : CuSO ₄ ·5H ₂ O : Se = 100 : 10 : 1, <i>w/w</i>), and then titration with 0.02 mol L ⁻¹ H ₂ SO ₄
Total P	Acid digestion and Mo-Sb colorimetry	A MAPADA V-1200 UV-Vis spectrophotometer after digestion with H ₂ SO ₄ -HClO ₄
Dissolved organic C	Water extraction and dry combustion method	A Shimadzu TOC-V CPH TOC analyzer (Kyoto, Japan) after extraction with a 1:10 soil (or PSB) to water ratio (<i>w/v</i>)
NH ₄ ⁺ -N (or NO ₃ ⁻ -N)	KCl extraction and continuous flow method	A SKALAR San++ continuous flow analyzer (Breda, Netherlands) after extraction with 1 mol L ⁻¹ KCl
Olsen-extractable P	NaHCO ₃ extraction and Mo-Sb colorimetry	A MAPADA V-1200 UV-Vis spectrophotometer (Shanghai, China) after extraction with 0.05 mol L ⁻¹ NaHCO ₃ (pH 8.5)
Water-soluble Ca	Water extraction and atomic absorption spectrophotometry	A Purkinje General TAS-990 atomic absorption spectrophotometer (Beijing, China) after extraction with a 1:10 soil (or PSB) to water ratio (<i>w/v</i>)
C : N ratio (or C :	Division method	The molar ratio of total organic carbon content to total nitrogen

P ratio)

(or total phosphorus) of soil or PSB measured in mass

Table S2. Analytical methods used to determine the main physicochemical properties of the compound fertilizer and calcium superphosphate used in the present study.

Property	Method	Description
Moisture content	Lyophilization or oven drying method	A freeze dryer at -50°C for 48 h (compound fertilizer) or an oven at 105°C for 6–8 h (calcium superphosphate)
pH _{water}	Potentiometry	A Sartorius PB-10 pH meter equipped with a Sartorius pH/ATC electrode (Göttingen, Germany) after stirring at a 1:5 fertilizer-to-water ratio (<i>w/v</i>)
Total N	Alkalimetry after distillation	Steam distillation of NH ₃ yielded after digestion with H ₂ SO ₄ (reduction with Cr powder & HCl), and then back-titration of excess H ₂ SO ₄ with 0.5 mol L ⁻¹ NaOH
Total P	EDTA extraction and quinoline phosphomolybdate gravimetry	Precipitation, filtering, washing, drying, and weighing of quinoline phosphomolybdate after extraction with 0.1 mol L ⁻¹ EDTA
NH ₄ ⁺ -N	Acidimetry after distillation	Titration with 0.05 mol L ⁻¹ HCl after separation by cold-air distillation
NO ₃ ⁻ -N	Ultraviolet spectrophotometry	A MAPADA V-1200 UV-Vis spectrophotometer after extraction with 2.5 mol L ⁻¹ HOAc
Amide-N	Subtraction method	The content difference between total N and mineral N (i.e., NH ₄ ⁺ -N and NO ₃ ⁻ -N)
Water-soluble P	Water extraction and quinoline phosphomolybdate gravimetry	Precipitation, filtering, washing, drying, and weighing of quinoline phosphomolybdate after extraction with deionized water
Water-soluble Ca	Water extraction and atomic absorption spectrophotometry	A Purkinje General TAS-990 atomic absorption spectrophotometer (Beijing, China) after extraction with a 1:10 soil (or PSB) to water ratio (<i>w/v</i>)

Table S3. Soil moisture content (dry basis) in 0–40 cm soil layer in three types of tubes.

Tube type	Treatment	Moisture content (%)
S-tube	Control	18.4±0.0
	CF ₁₀₀	19.9±1.3
	CF ₉₀ B ₁₀	18.3±0.2
	CF ₈₅ B ₁₅	20.5±0.1

	CF ₈₀ B ₂₀	19.8±0.4
C-tube	Control	9.07±3.73
	CF ₁₀₀	12.5±0.1
	CF ₉₀ B ₁₀	8.88±2.91
	CF ₈₅ B ₁₅	9.01±2.63
	CF ₈₀ B ₂₀	9.58±0.76
O-tube	Control	14.5±2.5
	CF ₁₀₀	16.5±0.9
	CF ₉₀ B ₁₀	15.7±1.5
	CF ₈₅ B ₁₅	16.3±0.9
	CF ₈₀ B ₂₀	14.7±1.8

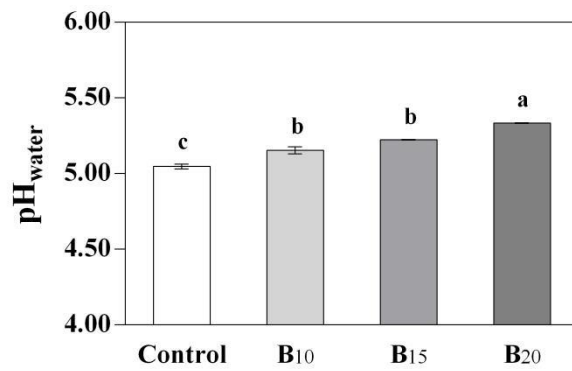


Figure S1. Effect of palm silk biochar (PSB) amendment on pH_{water} in soil without chemical fertilizer addition. Treatments: Control, no fertilization; B₁₀, 10% PSB-based fertilization; B₁₅, 15% PSB-based fertilization; B₂₀ 20% PSB-based fertilization. Data are expressed as means \pm SD ($n = 3$). Bars labeled with different lowercase letters (e.g., a, b, c, etc.) indicate significant ($p < 0.05$) differences among the rates of PSB application alone based on the Games–Howell test.