

Supplementary Materials

Regulatory Mechanism of Copper Oxide Nanoparticles on Uptake of Different Species of Arsenic in Rice

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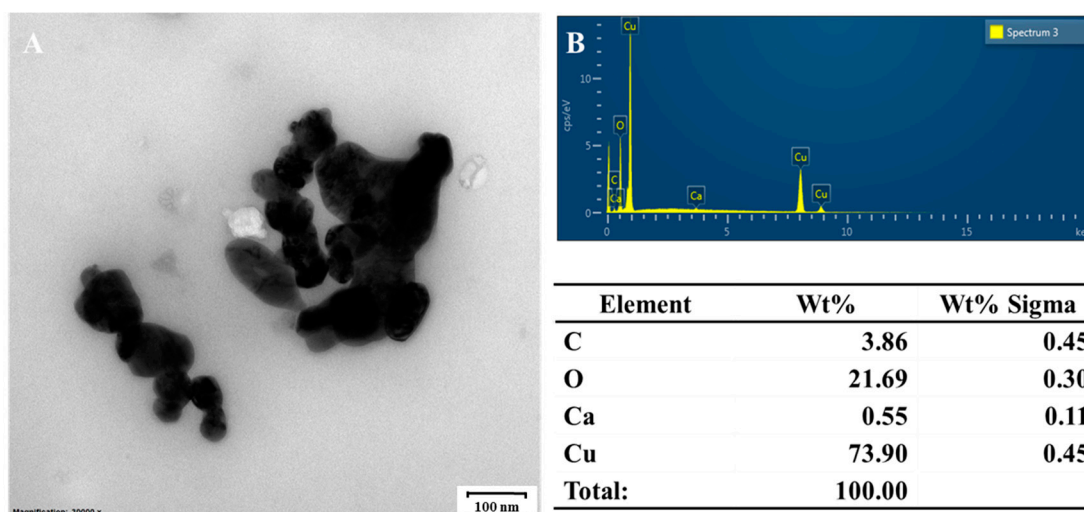


Figure S1. Morphology (A) and elemental composition (B) of CuO NPs.

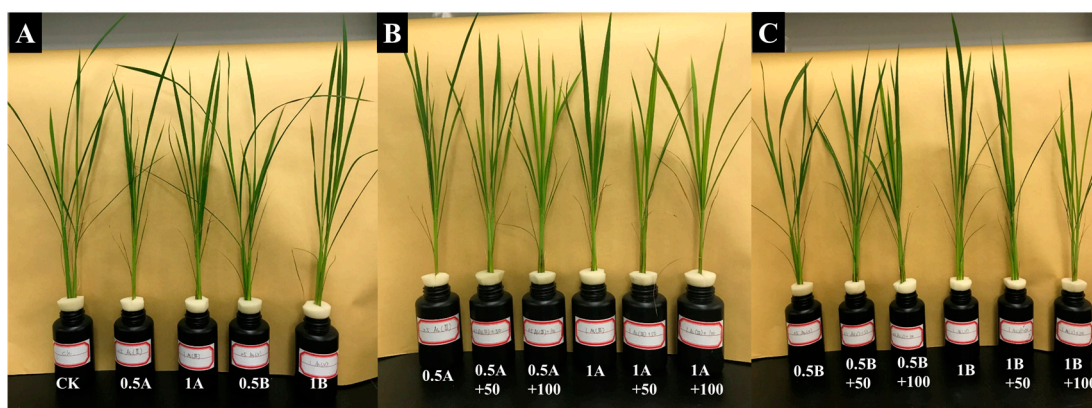


Figure S2. The culture system of rice seedlings in this study. (treatments from left to right in image (A) were CK, 0.5A, 1A, 0.5B and 1B, respectively; (B): 0.5A, 0.5A+50, 0.5A+100, 1A, 1A+50, 1A+100 treatments; (C): 0.5B, 0.5B+50, 0.5B+100, 1B, 1B+50, 1B+100 treatments.).

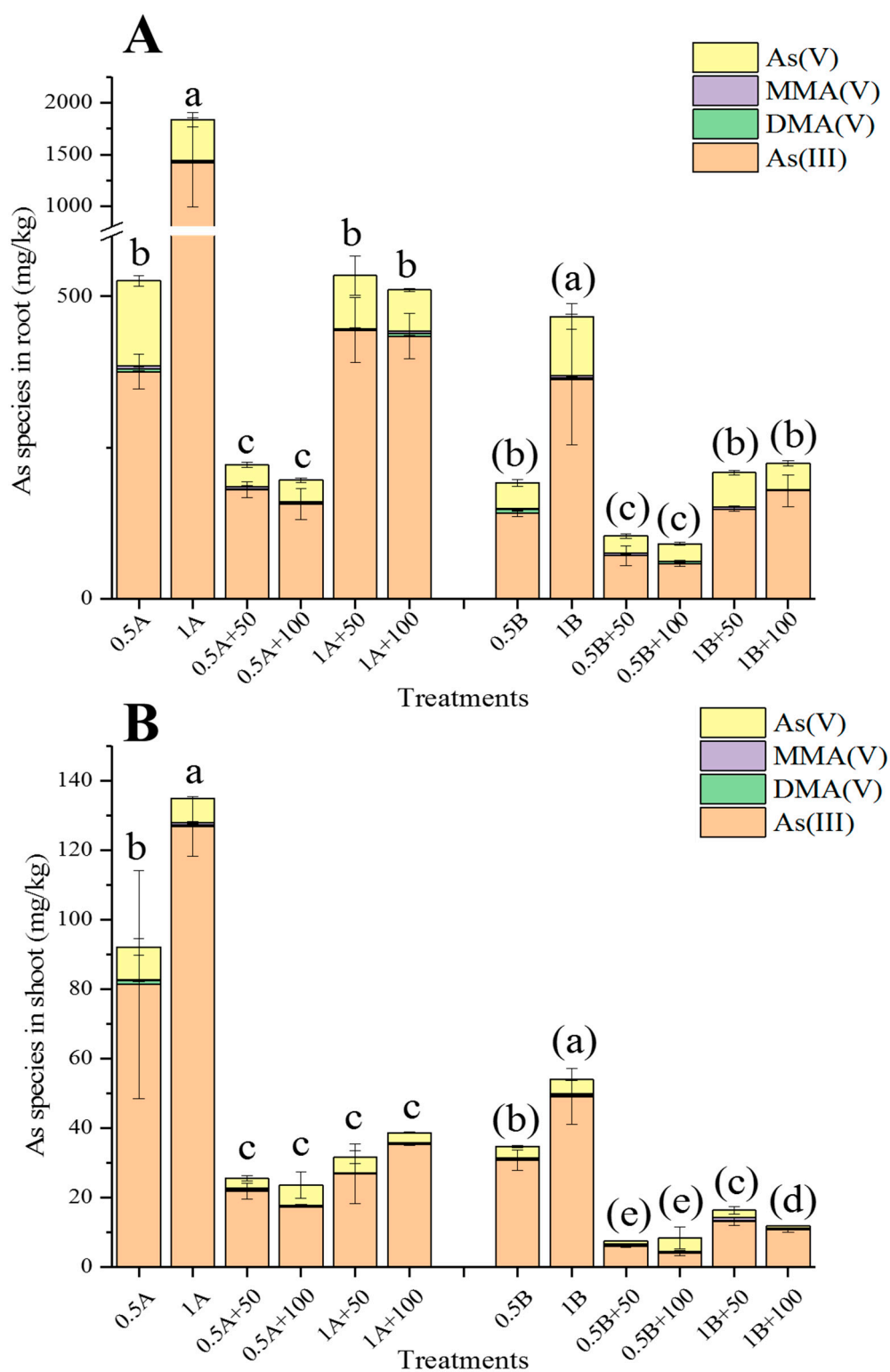


Figure S3. The concentrations and ratios of different species As in the roots (A) and shoots (B). Different lowercase letters indicate significant differences between different treatments ($p < 0.05$).

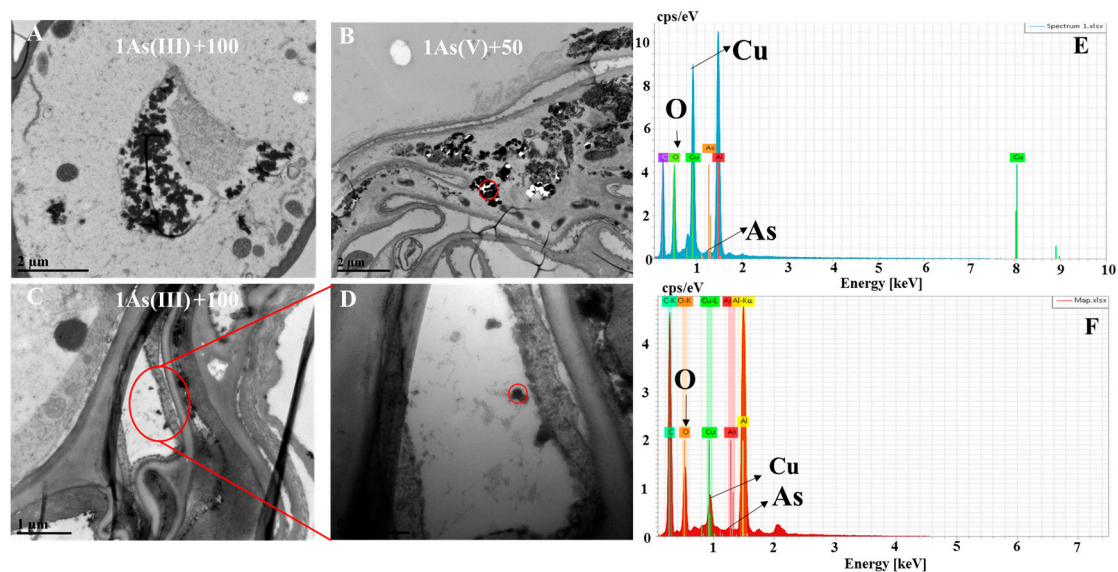


Figure S4. TEM-EDS analysis of rice root under different treatments. D is the magnify view of C. E and F are the EDS spectrum of B and D respectively.

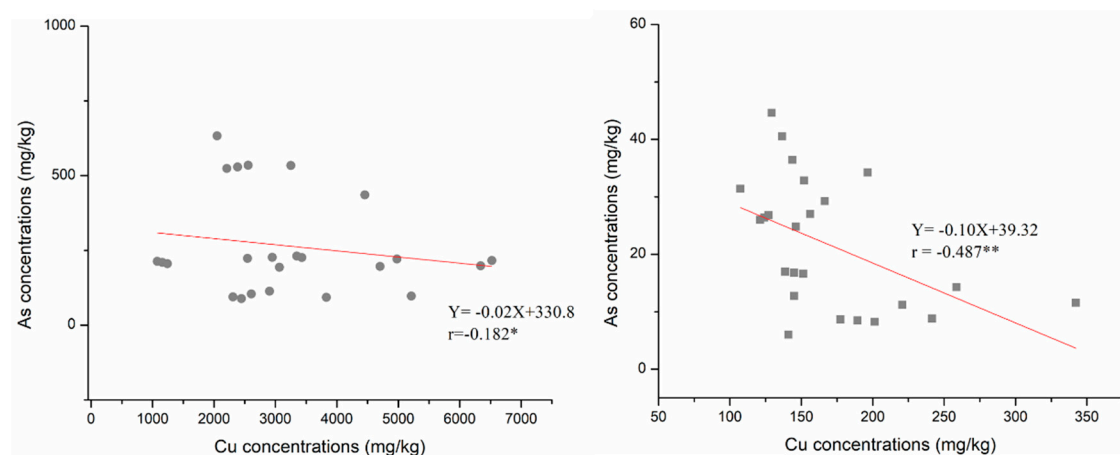


Figure S5. Pearson correlation between Cu and As concentration in rice root (A) and shoot (B).

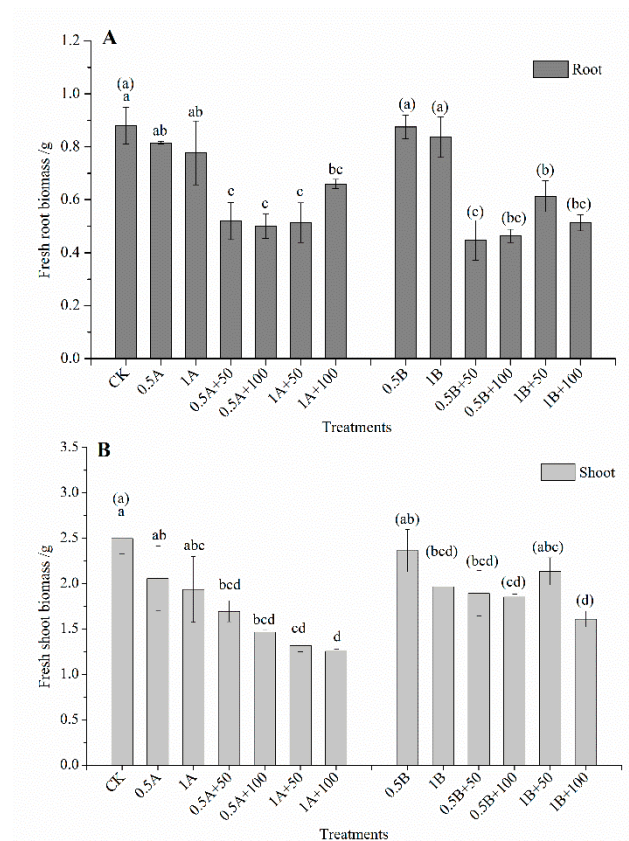


Figure S6. Root and shoot biomass of rice. Different lowercase letters indicate significant differences between different treatments ($p < 0.05$).

Table S1 Primer sequences for q-PCR.

Function	Gene name	Primer	Sequence 5'→3'	References
Transport and efflux of As(III)	<i>OsNIP3;2</i>	Former	GTGGCAGTCGGAGCAACAATCAT	Chen et al., 2017
		Reverse	CTTCTCCAGCTACAGCACCAAGTG	
	<i>Lsi1</i>	Former	ATCTACTTCCTGGGCCAGT	
		Reverse	AGGAGAGCTTCTGGGAGGAG	
	<i>Lsi2</i>	Former	ATCACCTTCCCCAAGTTCC	
		Reverse	CAGCTCCCTCCAGTACATGC	
As accumulation	<i>OsNIP1;1</i>	Former	GGACTAGTATGGCAGGAGGTGACAACAA	Cui et al., 2020
		Reverse	GGACTAGTTTtaggtggaggagttcatcc	
	<i>OsNIP3;3</i>	Former	GAAGATCTATGGAAGGGCACAAGAGTGG	
		Reverse	GGACTAGTCTACAGCTTAATTGCAACAT	
Transport of As(V)	<i>OsPT4</i>	Former	TTCTGCTAGTGTACCAAACAAAATTACA	Cao et al., 2017
		Reverse	GTAAGTGGCATTTATAATATCAACAGTAA CC	
	<i>OsPT1</i>	Former	CGCTTCCGTACGAGTGGTAGT	Wang et al., 2016
		Reverse	GGTTCTTTCAAATCCAGGGAAA	
	<i>OsPT8</i>	Former	AGAAGGCCAAAAGAAATGTGTGTTAAAT	
		Reverse	AAAATGTATTCTGTGCCAAATTGCT	
Reduction of As(V)	<i>OsHAC1;1</i>	Former	TGAACAAGGGCCATCTACAC	Shi et al., 2016
		Reverse	GACGAGAACTGCTCCACAAA	
	<i>OsHAC1;2</i>	Former	TAGCATCTGCCGATCTCATA	
		Reverse	GAGGTTTATTCACCCGAAGG	
	<i>OsHAC4</i>	Former	TGGCTTCACTCTTCGGCAA	Xu et al., 2017
		Reverse	CATTCTTGAATCCC GCGTCCA	
Actin	<i>OsActin</i>	Former	CTTCATAGGAATGGAAGCTGCGGGTA	
		Reverse	CGACCACCTTGATCTTCATGCTGCTA	

References of table S1:

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Table S2. The two-way ANOVA and Tukey multiple range tests for the effects of As(III) + CuO NPs on the Cu and As concentrations in rice.

As(III)	CuO NPs	Cu-root	Cu-shoot	As-root	As-shoot
0	0	107.1±4.53 c ⁽¹⁾	33.74±0.99 c	ND ⁽³⁾	ND
0.5	0	47.22±19.39 d	76.95±27.46 bc	525.5±41.3 b	105.0±19.5 a
1	0	9.39± 1.12 e	53.37±4.76 c	2112±203 a	136.9±8.12 b
0.5	50	4978±1546 a	124.1±2.91 ab	221.1±4.82 c	26.38±0.40 c
0.5	100	4703±1637 a	156.3±10.12 a	196.0±2.55 c	27.04±3.13 c
1	50	3253±1202 ab	152.0±44.6 a	534.2±98.7 b	32.82±1.41 c
1	100	2383±174 b	136.6±7.24 a	529.1±5.21 b	40.52±5.78 c
Source of variation		Cu-root	Cu-shoot	As-root	As-shoot
As		4.463 ^{*(2)}	2.501	395.5 ^{**}	219.3 ^{**}
CuO NPs		31.43 ^{**}	28.63 ^{**}	238.5 ^{**}	238.7 ^{**}
As*CuO NPs		2.248	2.944	105.8 ^{**}	13.36 ^{**}

⁽¹⁾ Values are means ± SD (n = 3). Different lowercase letters following values in the same column indicate significant differences ($P \leq 0.05$) between treatments.

⁽²⁾ F-values for the As(III) treatment and CuO NPs treatment As(III)*CuO NPs interaction. * and ** indicate significant at $P \leq 0.05$ and 0.01, respectively.

⁽³⁾ Values are below detectable limit.

Table S3. The two-way ANOVA and Tukey multiple range tests for the effects of As(V) + CuO NPs on the Cu and As concentrations in rice.

As(V)	CuO NPs	Cu-root	Cu-shoot	As-root	As-shoot
0	0	107.1±4.53 ⁽¹⁾ d	33.74±0.99 c	ND	ND
0.5	0	80.29±14.18 e	44.21±3.13 c	191.5±34.1 b	38.40±0.69 b
1	0	16.87±0.72 f	37.07±2.14 c	485.5±68.8 a	61.39±0.06 a
0.5	50	2607±298 ab	189.4±12.0 a	104.1±9.44 c	8.47±0.20 e
0.5	100	3830±138 a	241.6±100.6 a	93.02±4.31 c	8.79±2.79 e
1	50	1161±83 c	145.0±6.34 ab	209.6±3.86 b	16.78±0.19 c
1	100	2947±399 ab	208.1±57.9 a	227.0±3.98 b	12.73±1.55 d
Source of variation		Cu-root	Cu-shoot	As-root	As-shoot
As		4.622* ⁽²⁾	0.948	215.2**	1830**
CuO NPs		54.10**	27.28**	75.18**	1911**
As*CuO NPs		2.338	0.282	17.94**	97.52**

⁽¹⁾ Values are means ± SD (n = 3). Different lowercase letters following values in the same column indicate significant differences ($P \leq 0.05$) between treatments.

⁽²⁾ F-values for the As(V) treatment and CuO NPs treatment As(V)*CuO NPs interaction. * and ** indicate significant at $P \leq 0.05$ and 0.01, respectively.