

Supplementary Material

The uptake of Arsenic species by commonly grown Australian rice varieties cultivated utilising two widely used agronomic practices (straw incorporation and nitrogen fertilisation) and the role dimethyl arsenic plays in inducing straighthead disease

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Supporting data

Table S1: Supporting data for arsenic concentrations of different arsenic species in milled grains for each plot and rice variety analysed with corresponding plot sterility. Data shows associated treatments for each plot; Straw indicates the incorporation of straw (S+) or no straw incorporation (S-) into the soil and nitrogen indicates the addition of nitrogen (N+) or no nitrogen addition (N-) to the plot at rice PI in the form of urea. Limit of detection (LOD) = $0.005 \mu\text{g g}^{-1}$

Variety	Straw	Nitrogen	Inorganic ($\mu\text{g g}^{-1}$)	DMA ($\mu\text{g g}^{-1}$)	MA ($\mu\text{g g}^{-1}$)	Total As ($\mu\text{g g}^{-1}$)	Sterility (%)
Koshihikari	S-	N-	0.18	0.56	LOD	0.73	19
Koshihikari	S-	N-	0.14	0.46	LOD	0.60	9
Sherpa	S-	N-	0.16	0.85	0.07	1.08	20
Sherpa	S-	N-	0.17	0.50	LOD	0.67	22
Doongara	S-	N-	0.08	0.91	LOD	0.99	47
Doongara	S-	N-	0.16	0.22	LOD	0.38	26
Topaz	S-	N-	0.16	0.50	LOD	0.66	40
Topaz	S-	N-	0.09	0.41	LOD	0.50	42
Doongara	S-	N+	0.10	0.58	LOD	0.68	50
Doongara	S-	N+	0.12	0.49	LOD	0.61	32
Koshihikari	S-	N+	0.15	0.63	LOD	0.78	22
Koshihikari	S-	N+	0.15	0.56	LOD	0.72	20
Sherpa	S-	N+	0.12	0.55	LOD	0.67	17
Sherpa	S-	N+	0.13	0.56	LOD	0.69	13
Topaz	S-	N+	0.10	0.95	0.04	1.09	65
Topaz	S-	N+	0.08	0.40	0.01	0.48	35
Doongara	S+	N-	0.10	1.51	0.03	1.64	91
Koshihikari	S+	N-	0.13	1.67	0.06	1.85	73
Koshihikari	S+	N-	0.11	0.48	0.05	0.64	20
Sherpa	S+	N-	0.11	1.09	0.05	1.25	23
Sherpa	S+	N-	0.10	0.48	0.02	0.60	18
Topaz	S+	N-	0.09	0.80	0.03	0.92	73
Topaz	S+	N-	0.07	1.06	LOD	1.13	59
Doongara	S+	N+	0.07	1.19	LOD	1.27	89
Doongara	S+	N+	0.09	0.73	LOD	0.81	96
Koshihikari	S+	N+	0.13	1.14	0.01	1.27	44
Koshihikari	S+	N+	0.12	0.72	LOD	0.83	24
Sherpa	S+	N+	0.08	1.44	0.02	1.55	21
Sherpa	S+	N+	0.09	0.82	LOD	0.91	27
Topaz	S+	N+	0.13	1.04	LOD	1.17	72
Topaz	S+	N+	0.07	0.98	LOD	1.04	89

Table S2: Supporting data for arsenic concentrations in the husks of Koshihikari plants. The table presents total, inorganic, DMA and MA concentrations with corresponding plant health and agronomic treatment. Straw indicates the incorporation of straw (S+) or no straw incorporation (S-) into the soil and nitrogen indicates the addition of nitrogen (N+) or no nitrogen addition (N-) to the plot at rice PI in the form of urea.

Plant Health	Straw	Nitrogen	Total ($\mu\text{g g}^{-1}$)	Inorganic ($\mu\text{g g}^{-1}$)	DMA ($\mu\text{g g}^{-1}$)	MA ($\mu\text{g g}^{-1}$)
Healthy	S+	N+	1.82	0.38	0.49	0.02
Healthy	S+	N+	1.96	0.39	0.61	LOD
Healthy	S+	N+	1.98	0.48	0.60	0.01
Straighthead	S+	N+	3.54	1.01	1.76	0.10
Straighthead	S+	N+	3.64	0.99	1.48	0.11
Straighthead	S+	N+	2.76	0.75	1.44	0.07
Healthy	S+	N-	2.89	0.80	1.45	0.06
Healthy	S+	N-	2.46	0.58	0.53	0.01
Healthy	S+	N-	1.93	0.51	0.47	LOD
Straighthead	S+	N-	5.26	1.26	1.47	0.10
Straighthead	S+	N-	4.41	0.80	1.43	0.11
Straighthead	S+	N-	5.68	1.44	1.71	0.08
Healthy	S-	N+	3.10	0.86	0.48	0.00
Healthy	S-	N+	3.42	0.85	0.69	0.00
Healthy	S-	N+	3.38	0.78	0.67	0.00
Straighthead	S-	N+	4.93	1.58	1.26	0.04
Straighthead	S-	N+	4.62	1.05	1.40	0.07
Straighthead	S-	N+	4.54	1.51	1.13	0.05
Healthy	S-	N-	3.55	1.28	0.68	LOD
Healthy	S-	N-	2.49	0.77	0.40	LOD
Healthy	S-	N-	2.44	0.76	0.61	LOD
Straighthead	S-	N-	8.05	2.35	1.88	0.08
Straighthead	S-	N-	6.03	3.56	1.36	0.05
Straighthead	S-	N-	6.97	1.94	2.69	0.11

Table1S3: Supporting data for arsenic concentrations in the leaves of Koshihikari plants. The table presents total, inorganic, DMA and MA concentrations with corresponding plant health and agronomic treatment. Straw indicates the incorporation of straw (S+) or no straw incorporation (S-) into the soil and nitrogen indicates the addition of nitrogen (N+) or no nitrogen addition (N-) to the plot at rice PI in the form of urea.

Plant Health	Straw	Nitrogen	Total ($\mu\text{g g}^{-1}$)	Inorganic ($\mu\text{g g}^{-1}$)	DMA ($\mu\text{g g}^{-1}$)	MA ($\mu\text{g g}^{-1}$)
Healthy	S+	N+	5.66	5.31	0.31	0.04
Healthy	S+	N+	4.98	4.61	0.32	0.06
Healthy	S+	N+	7.13	6.86	0.27	LOD
Straighthead	S+	N+	6.27	5.68	0.54	0.05
Straighthead	S+	N+	7.08	5.91	1.07	0.10
Straighthead	S+	N+	5.98	5.39	0.53	0.06
Healthy	S+	N-	7.08	6.52	0.50	0.06
Healthy	S+	N-	8.90	8.54	0.34	0.03
Healthy	S+	N-	5.77	5.56	0.19	0.01
Straighthead	S+	N-	6.18	5.30	0.81	0.08
Straighthead	S+	N-	6.09	5.16	0.88	0.05
Straighthead	S+	N-	8.33	7.29	1.01	0.03
Healthy	S-	N+	19.19	18.58	0.56	0.06
Healthy	S-	N+	21.00	20.10	0.82	0.07
Healthy	S-	N+	19.78	19.16	0.56	0.05
Straighthead	S-	N+	17.43	16.43	0.91	0.09
Straighthead	S-	N+	14.37	13.55	0.78	0.04
Straighthead	S-	N+	12.61	11.89	0.63	0.09
Healthy	S-	N-	15.25	14.52	0.69	0.04
Healthy	S-	N-	14.54	13.84	0.63	0.06
Healthy	S-	N-	12.83	12.43	0.38	0.02
Straighthead	S-	N-	13.57	12.77	0.73	0.08
Straighthead	S-	N-	10.69	9.95	0.71	0.04
Straighthead	S-	N-	13.71	12.70	0.96	0.04

Table S4. Supporting data for arsenic concentrations in the shoots of Koshihikari plants. The table presents total, inorganic, DMA and MA concentrations with corresponding plant health and agronomic treatment. Straw indicates the incorporation of straw (S+) or no straw incorporation (S-) into the soil and nitrogen indicates the addition of nitrogen (N+) or no nitrogen addition (N-) to the plot at rice PI in the form of urea.

Plant Health	Straw	Nitrogen	Total ($\mu\text{g g}^{-1}$)	Inorganic ($\mu\text{g g}^{-1}$)	DMA ($\mu\text{g g}^{-1}$)	MA ($\mu\text{g g}^{-1}$)
Healthy	S+	N+	2.31	2.06	0.24	LOD
Healthy	S+	N+	2.12	1.87	0.25	LOD
Healthy	S+	N+	2.72	2.44	0.28	LOD
Straighthead	S+	N+	2.26	1.87	0.39	LOD
Straighthead	S+	N+	2.37	2.00	0.35	0.03
Healthy	S+	N-	3.80	3.33	0.41	0.06
Healthy	S+	N-	3.45	3.15	0.26	0.04
Healthy	S+	N-	2.56	2.36	0.20	LOD
Straighthead	S+	N-	2.74	2.31	0.42	0.01
Straighthead	S+	N-	2.76	2.29	0.44	0.03
Straighthead	S+	N-	2.99	2.61	0.37	0.02
Healthy	S-	N+	8.14	7.72	0.42	LOD
Healthy	S-	N+	6.31	5.86	0.45	LOD
Healthy	S-	N+	5.61	5.24	0.37	LOD
Straighthead	S-	N+	5.76	5.25	0.50	0.02
Straighthead	S-	N+	5.11	4.62	0.46	0.03
Straighthead	S-	N+	5.09	4.64	0.43	0.01
Healthy	S-	N-	5.76	5.43	0.33	LOD
Healthy	S-	N-	6.29	5.96	0.28	0.06
Healthy	S-	N-	5.84	5.23	0.52	0.09
Straighthead	S-	N-	3.84	3.48	0.32	0.04
Straighthead	S-	N-	4.57	4.10	0.45	0.02
Straighthead	S-	N-	4.60	4.18	0.36	0.06

Table S5. Certified reference material concentrations*Total As concentrations*

Certified Reference Material	Measured ($\mu\text{g g}^{-1}$)	Certified ($\mu\text{g g}^{-1}$)
NIST 10a Rice Flour	0.18 ± 0.03 (n = 11)	0.17
NIST SRM 1575 Pine Needles	0.18 ± 0.04 (n = 11)	0.21 ± 0.04
SRM 8704 Buffalo River Sediment	14 (n = 1)	17
SRM 2710 Montana Soil	511 (n = 1)	626 ± 36

Arsenic species in NIST 10a Rice Flour

As species	Measured ($\mu\text{g g}^{-1}$)	Certified ($\mu\text{g g}^{-1}$)
As(III)	0.28 ± 0.02 (n = 20)	
DMA	0.014 ± 0.002 (n = 20)	
As(V)	0.04 ± 0.02 (n = 20)	

Figure S1: HPLC-ICPMS Chromatograms of arsenic speciation. Top panel, an example of 25mg/L standard of four As species (As^{3+} , DMA MA and As^{5+}). Bottom panel, Arsenic speciation for Koshihikari rice leaf sample detected arsenic species.

