Supplementary Data

Cobalt in soil-plant system across deficient, beneficial and toxic levels: Data analysis and mechanistic interpretations

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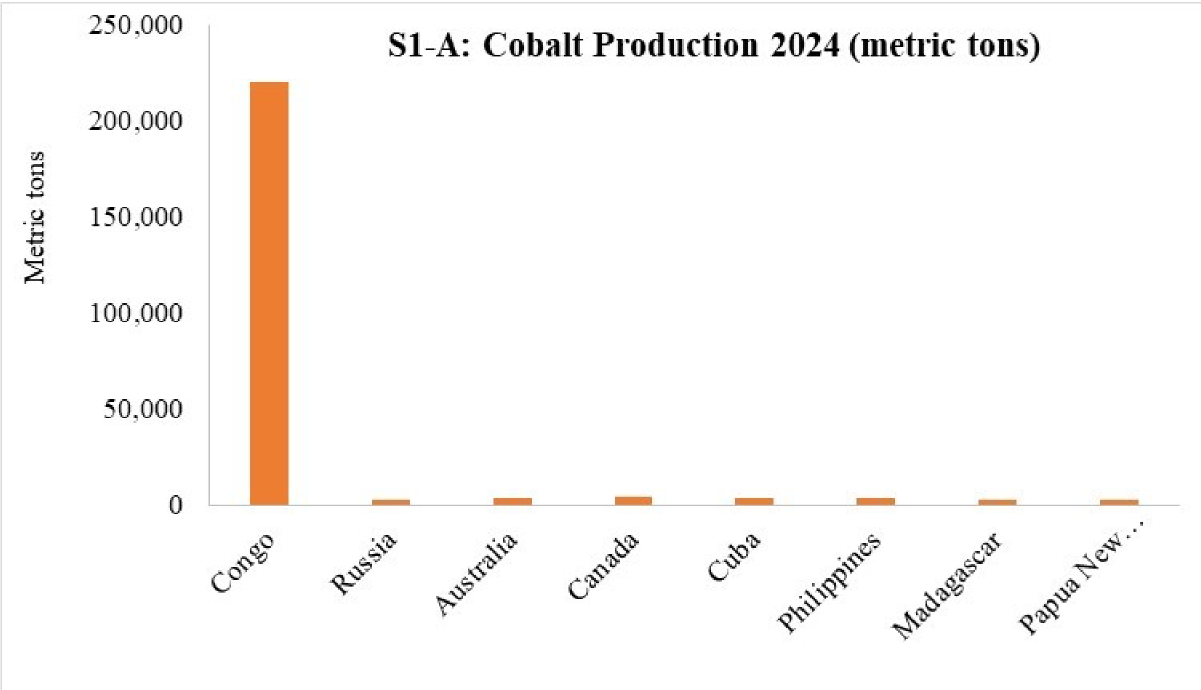
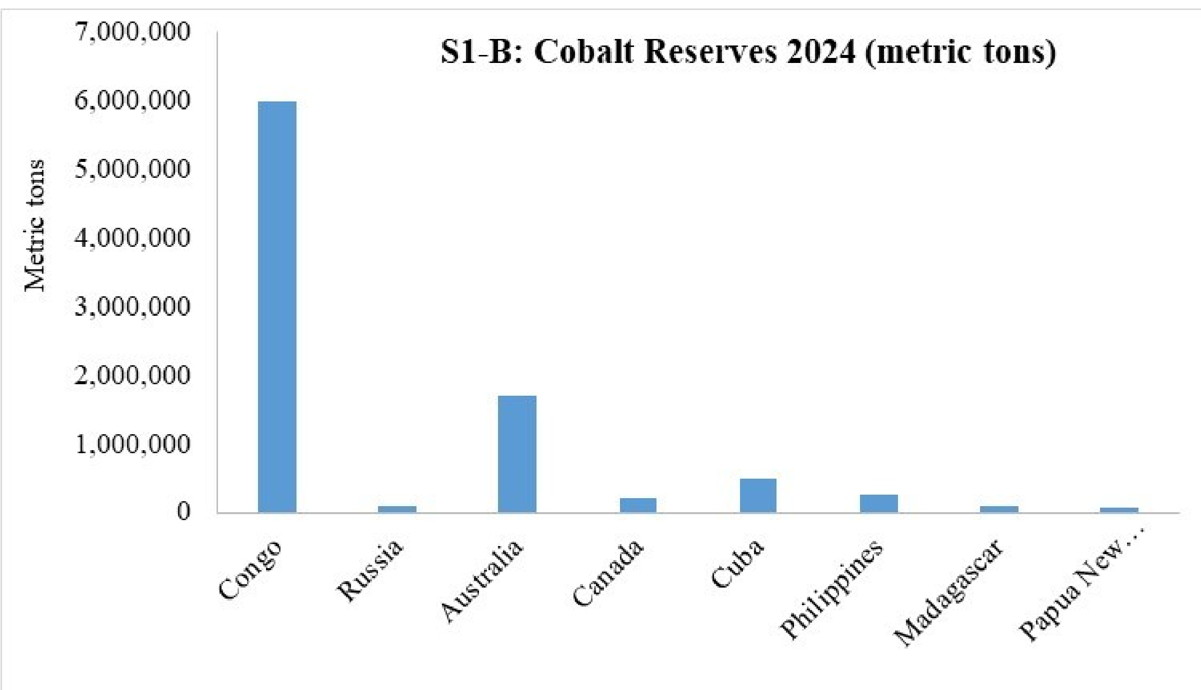
S1. Synthesis and application of cobalt-based composites

Keeping in view the role of Co towards nitrogen (N) fixation, it has attracted a huge interest among scientists to prepare Co-based photocatalysts. Recent developments have assessed the role of these Co-based photocatalysts to enhance N fixation in plants [1]. For example, a photocatalyst based on organic-ligand-doped Co-Fe oxides can enhance N fixation at normal temperature and pressure [2]. Similarly, Shen *et al.* [3] synthesized a Co oxide@Schiff, which has an N fixation capacity throughout the day [2880 μg/(L•h)] under normal temperature and pressure. Another catalyst (MXene/TiO2/Co-0.5%) showed enhanced potential of NH^{4+} yield rate (110 μmol g^{-1} h^{-1}) [4]. Recently, Co was doped with a porous graphitic carbon nitride (g-C_3N_4) by Yu *et al.* [5] to produce a g-C_3N_4-based electrocatalyst, which has the potential of enhanced NH^{4+} production rate (49.7 $\mu g \cdot h^{-1} \cdot mg_{cat.}^{-1}$).

In addition to N fixation potential, the composites of Co with other metals have been used for several other applications, especially in medical science. A polysaccharide Co complex (TPS-Co) was prepared by Zhou *et al.* [6], which showed an excellent cell proliferation effect, thereby proving its potential applications in bone regeneration. Similarly, Elderdery *et al.* [7] prepared Ni-Co-codoped Tin-oxide ($SnNiCoO_2$) nanoparticles, which exhibited strong anticancer and antimicrobial potential and can be used for cancer treatment. A catalyst based on Co oxide-alumina (Al_2O_3–Co) containing 15% Co showed an excellent potential (98.1% at 750 °C) to convert toxic gas SO_2 into sulfur. Hence, Co has numerous beneficial applications as a composite with other materials. Recently, Dai *et al.* [8] reported that composites of Co with metal-organic frameworks (CoFe-MOFs) can act as peroxymonosulfate activators to degrade antibiotics. Shi *et al.* [9] prepared Co and N co-doped carbon foam (Co-NCF-11), which exhibited outstanding peroxymonosulfate activation potential. Moreover, the germination tests using wheat revealed low toxicity of the degraded solution. Moreover, notable degradation efficacies were observed in the dechlorination process using soluble Co complexes (CoTTMeAPc) [10].

Figure S1: Comparison of cobalt production (S1-A), reserves (S1-B), and reserves vs production (S1-C) at the global stage (source USGS 2025).





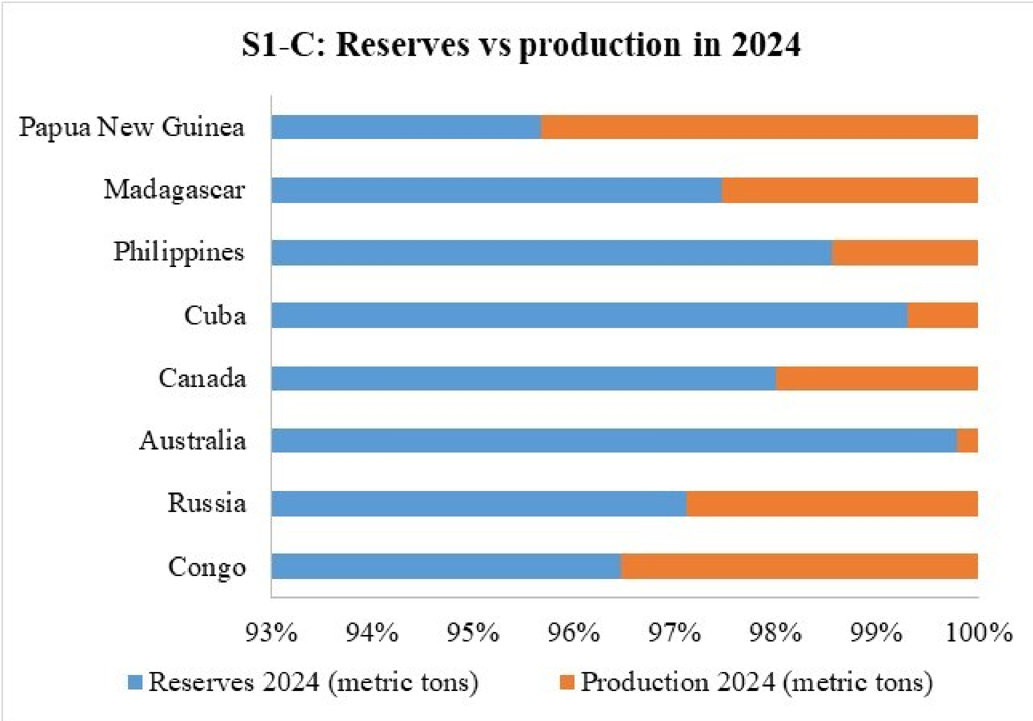

S1-C: Reserves vs production in 2024
Papua New Guinea
Madagascar
Philippines
Cuba
Canada
Australia
Russia
Congo
93%
94%
95%
96%
97%
98%
99%
100%
Reserves 2024 (metric tons)
Production 2024 (metric tons)

Figure S2: Dose-response relationship trends between cobalt and plant growth parameters.

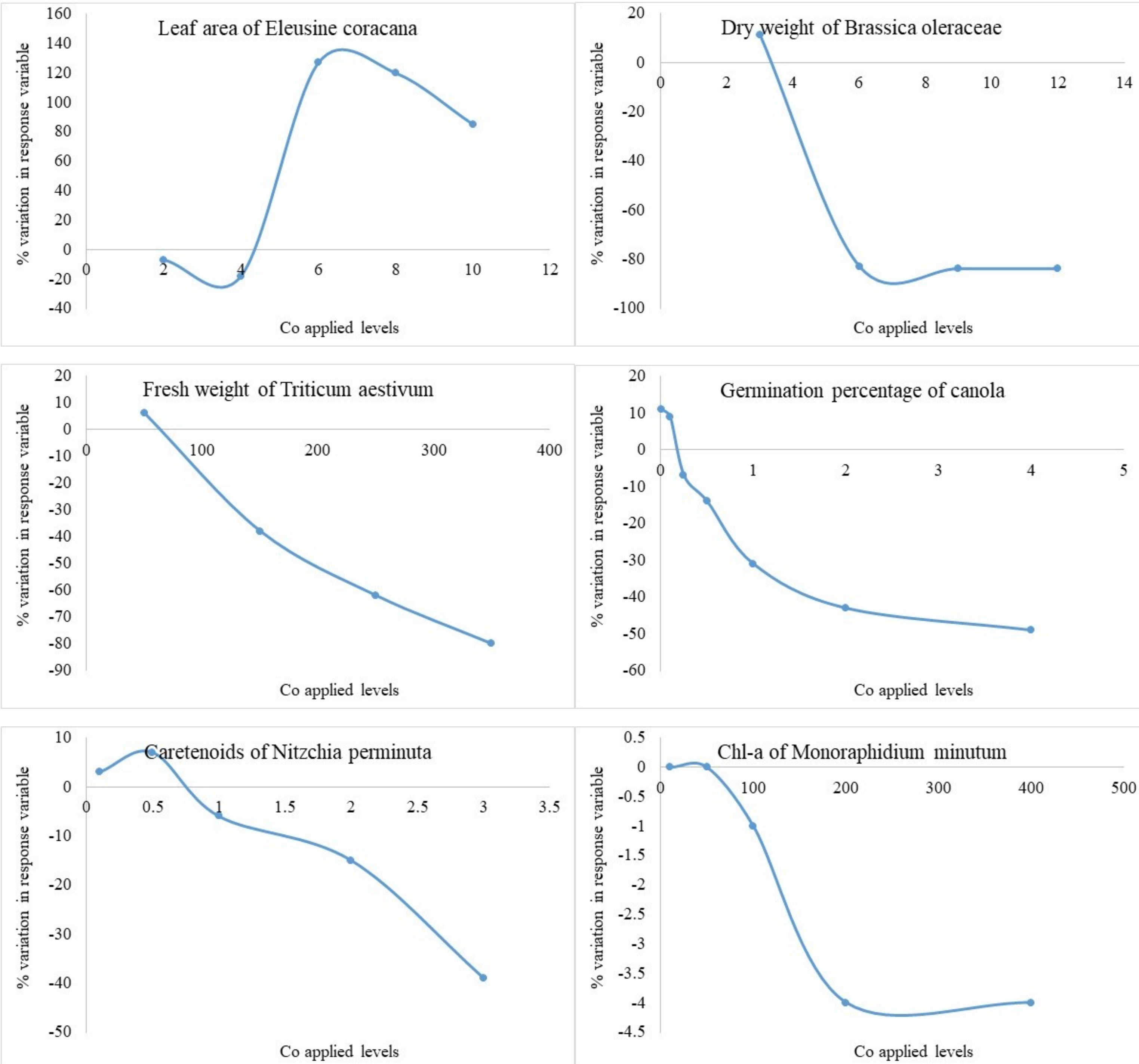


Figure S3: Cobalt functions in human body.

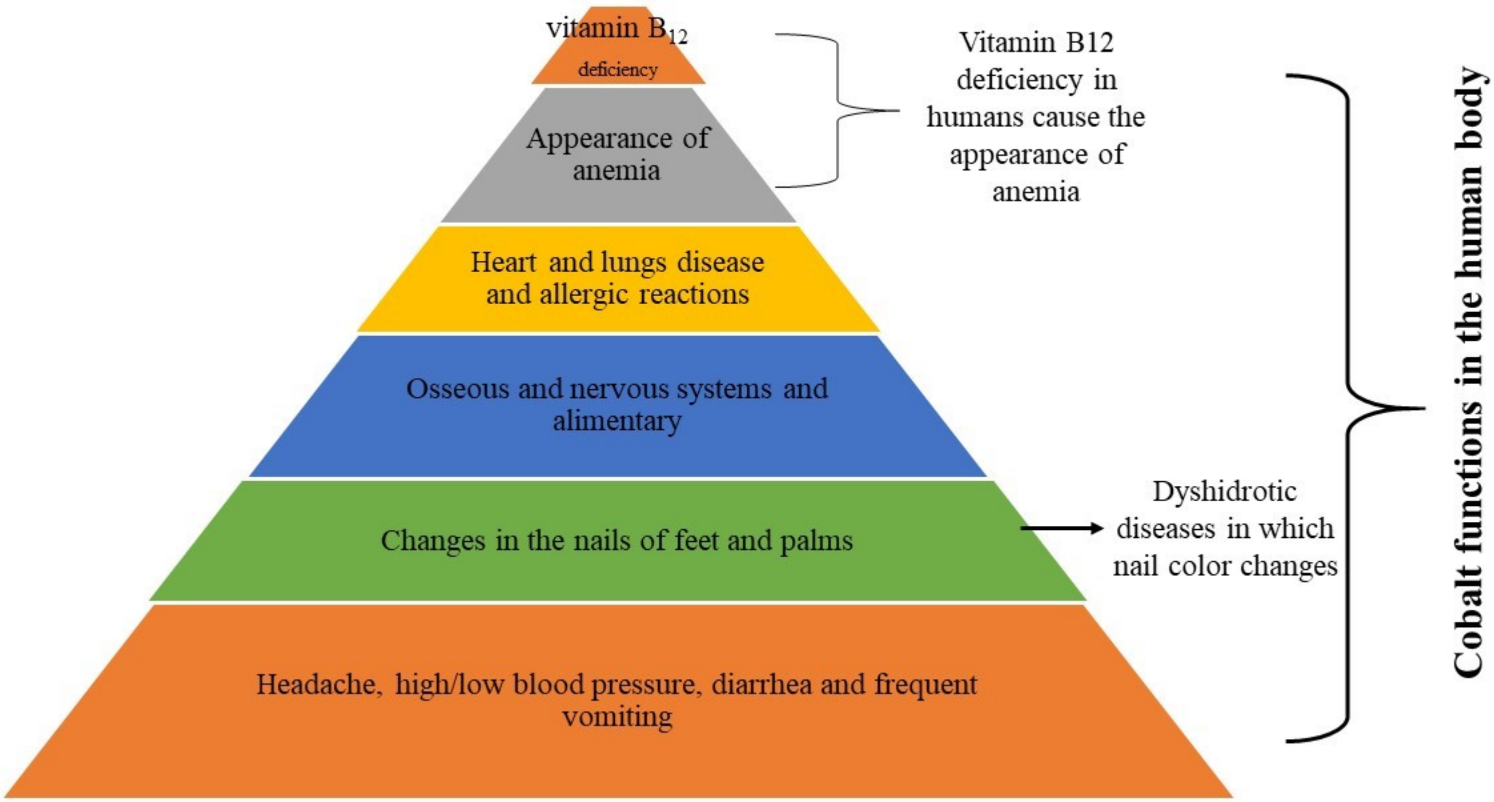


Table S1: Percent Co accumulation in plants parts cultivated in Co contaminated solution

Root %	Shoot %	Dose	Plant	Co in Root	Co in Shoot	Reference
73	27	0.8 mg/kg	Water spinach	1.1	0.4	
50	50	0.9 mg/kg	White jute	0.2	0.2	11
50	50	1.0 mg/kg	Malabar spinach	0.4	0.4	
79	21	50 µM	Barley	9.45	2.56	12
80	20			6.91	1.74	
91	9	25 mg/kg	Corn	10	1	13
87	13	65 mg/kg		130	20	
82	18	125 mg/kg		300	65	
82	18	185 mg/kg		325	70	
66	34	5 ppm	*Vicia faba L.*	2.31	1.17	14
78	22	10 ppm		5.56	1.53	
79	21	15 ppm		8.91	2.39	
71	29	20 ppm		11	4.5	
35	65	5 mg/kg	*Ipomoea batatas L*	1.76	3.2	15
33	67	7.5 mg/kg		2.48	5.01	
26	74	10 mg/kg		3.02	8.6	
32	68	12.5 mg/kg		4.95	10.6	
34	66	15 mg/kg		6.18	11.9	
35	65	5 mg/kg	*Ipomoea batatas L*	1.84	3.4	
34	66	7.5 mg/kg		2.62	5.04	
28	72	10 mg/kg		3.41	8.8	
28	72	12.5 mg/kg		4.25	10.9	
34	66	15 mg/kg		6.36	12.2	
94	6	200 µM	*Lactuca sativa L*	873	58	16
45	55	100 µM	*Zea mays L.*	18.8	23.2	17
76	24	200 µM		385	123	
67	33	0.025 mg/dm3	*Dendrobium kingianum*	400	200	18
74	26	0.625 mg/dm3		1000	350	
74	26	1.250 mg/dm^3		1300	450	
78	22	2.5 mg/dm^3		4000	1100	
14	86	50 µm	*Phaseolus aureus Roxb*	11	66	19
17	83	100 µm		17	84	
21	79	200 µm		25	96	
17	83	300 µm		20	98	
18	82	400 µm		19	87	

51	49	50 mg/kg		0.85	0.83	
51	49	100 mg/kg	*Glycine max (L.)*	0.92	0.89	20
51	49	150 mg/kg		0.98	0.96	
51	49	200 mg/kg		1.13	1.07	
51	49	250 mg/kg		1.19	1.16	
49	51	50 mg/kg		0.68	0.71	
49	51	100 mg/kg		0.76	0.78	
49	51	150 mg/kg	*Glycine max (L.)*	0.81	0.85	20
48	52	200 mg/kg		0.84	0.9	
48	52	250 mg/kg		0.89	0.96	
49	51	50 mg/kg		0.81	0.84	
49	51	100 mg/kg		0.88	0.92	
49	51	150 mg/kg	*Glycine max (L.)*	0.96	0.99	20
49	51	200 mg/kg		1.05	1.09	
49	51	250 mg/kg		1.11	1.16	
2	98	10 mg/kg	*Berkheya coddii*	2	90	21
6	94	100 mg/kg		80	1200	
96	4	5 mg/kg	*Triticum aestivum*	2080	76	22
97	3	10 mg/kg		4960	175	
98	2	5 mg/kg	*Lycopersicon esculentum*	2220	50	22
96	4	10 mg/kg		2950	135	
72	28	3 g/L		0.5	0.19	
75	25	3 g/L		0.6	0.2	
76	24	3 g/L		0.7	0.22	
86	14	3 g/L	Peanut	0.3	0.05	23
90	10	3 g/L		0.35	0.04	
86	14	3 g/L		0.6	0.1	
85	15	3 g/L		0.7	0.12	
50	50	NM	Wheat	1.02	1.04	24

Table S2: Percent variation in different growth variables of plant shoots in response to Co

Co dose	Growth	% change	Organ	Plant species	Control Values	Co-treated Value	Reference
0.11 mg/L	Cell density	-43.3	Leaf		3	1.7	
0.32 mg/L	Cell density	-51.6	Leaf	*Raphidocelis subcapitata*	3	1.45	25
0.54 mg/L	Cell density	-75	Leaf		3	0.75	
0.11 mg/L	Quantum yield	-10.7	Leaf		0.65	0.58	
0.32 mg/L	Quantum yield	-12.3	Leaf	*Raphidocelis subcapitata*	0.65	0.57	25
0.54 mg/L	Quantum yield	-13.8	Leaf		0.65	0.56	
7.5 mg/L	Pod weight	33.3	Pods		60	80	
7.5 mg/L	Pod weight	2.5	Pods	Peanuts	80	82	26
7.5 mg/L	Pod weight	200	Pods		20	60	
7.5 mg/L	Shoot fresh weight	14.2	Leaf		2.8	3.2	
7.5 mg/L	Shoot fresh weight	16.6	Leaf	Peanuts	3	3.5	26
7.5 mg/L	Shoot fresh weight	14.8	Leaf		2.7	3.1	
10 mg/L	Shoot fresh weight	47	Shoot	*Tagestes eracta*	8.6	12.6	27

20 mg/L		-14	Shoot	*Tagestes eracta*	8.6	7.4	
10 mg/L	Shoot dry weight	88	Shoot	*Tagestes eracta*	5.6	10.5	27
20 mg/L		-30	Shoot	*Tagestes eracta*	5.6	3.9	
10 mg/L	Flower fresh weight	15	Shoot	*Tagestes eracta*	8.2	9.4	27
20 mg/L		-32	Shoot	*Tagestes eracta*	8.2	5.6	
10 mg/L	Flower dry weight	11	Roots	*Tagestes eracta*	12.8	14.2	27
20 mg/L		-22	Roots	*Tagestes eracta*	12.8	10	
10 mg/L	Leaf area	36	Shoot	*Tagestes eracta*	14.3	19.4	27
20 mg/L		-8	Shoot	*Tagestes eracta*	14.3	13.2	
10 mg/L	Flower diameter	18	Roots	*Tagestes eracta*	15.2	17.9	27
20 mg/L		-57	Roots	*Tagestes eracta*	15.2	6.5	
50 µM	Dry weight	-72	Shoot	Barley	49.7	14.01	12
50 µM	Tissue length	-80			169.89	34.33	
2 mM	Tissue length	-11	Shoot	*Eleusine coracana (L.)*	17.16	15.26	28
4 mM		-22			17.16	13.46	
6 mM		-29			17.16	12.26	
8 mM		-32			17.16	11.66	
10 mM		-41			17.16	10.1	
2 mM	Leaf area	-7	shoot	*Eleusine coracana (L.)*	4.33	4.033	28
4 mM		-18			4.33	3.533	
6 mM		127			4.33	9.85	
8 mM		120			4.33	9.52	

10 mM		85			4.33	8.02	
2 mM	Fresh weight	-16	shoot	*Eleusine coracana (L.)*	0.25	0.21	28
4 mM		-44			0.25	0.14	
6 mM		-60			0.25	0.1	
8 mM		-64			0.25	0.09	
10 mM		-75			0.25	0.063	
2 mM	Dry weight	-17	shoot	*Eleusine coracana (L.)*	0.12	0.1	28
4 mM		-33			0.12	0.08	
6 mM		-42			0.12	0.07	
8 mM		-58			0.12	0.05	
10 mM		-67			0.12	0.04	
50 µM	Fresh weight	-11	Shoot	*Triticum aestivum L.*	2.93	2.62	29
150 µM		-37			2.93	1.85	
250 µM		-60			2.93	1.17	
350 µM		-77			2.93	0.68	
50 µM	Dry weight	-4	Shoot	*Triticum aestivum L.*	0.52	0.5	29
150 µM		-17			0.52	0.43	
250 µM		-38			0.52	0.32	
350 µM		-44			0.52	0.29	
50 µM	Water content	-1	Shoot	*Triticum aestivum L.*	82	81	29
150 µM		-6			82	77	
250 µM		-17			82	68	
350 µM		-30			82	57	
50 µM	Shoot Height	4	Shoot	*Triticum aestivum L.*	18.5	19.2	29
150 µM		-22			18.5	14.4	
250 µM		-48			18.5	9.7	
350 µM		-67			18.5	6.1	
50 µM	Leaf Area	10	Shoot	*Raphanus sativus L*	58.72	64.44	30
100µM		-6			58.72	55.35	
150 µM		-20			58.72	47.16	
200 µM		-32			58.72	39.67	
250 µM		-46			58.72	31.45	
50 µM	Length	10	Shoot	*Raphanus sativus L*	10.42	11.44	30
100µM		-19			10.42	8.45	
150 µM		-31			10.42	7.19	
200 µM		-35			10.42	6.74	
250 µM		-43			10.42	5.93	
3 ppm	Leaf Area	20	Shoot	*Brassica oleraceae L.*	336	404	31
6 ppm		45			336	488	
9 ppm		25			336	420	
12 ppm		15			336	387	
3 ppm	Fresh weight	-8	Shoot	*Brassica oleraceae L.*	439	404	31

6 ppm		11			439	486	
9 ppm		25			439	548	
12 ppm		17			439	512	
3 ppm	Dry weight	11	Shoot	*Brassica oleraceae L.*	46.6	51.7	31
6 ppm		-83			336	58	
9 ppm		-84			336	54.8	
12 ppm		-84			336	53.7	
3 ppm	Fresh weight	11	Shoot	*Brassica oleraceae L.*	36.9	41	31
6 ppm		25			36.9	46.2	
9 ppm		17			36.9	43	
12 ppm		15			36.9	42.3	
3 ppm	Dry weight	11	Shoot	*Brassica oleraceae L.*	9.55	10.6	31
6 ppm		11			9.55	15.3	
9 ppm		60			9.55	12.8	
12 ppm		34			9.55	10.9	
3 ppm	Phenols	7	Shoot	*Brassica oleraceae L.*	6.44	6.92	31
6 ppm		16			6.44	7.45	
9 ppm		9			6.44	7.02	
12 ppm		7			6.44	6.87	
3 ppm	Proteins	21	Shoot	*Brassica oleraceae L.*	9.85	11.91	31
6 ppm		21			9.85	19.41	
9 ppm		97			9.85	18.09	
12 ppm		84			9.85	11.79	
50 µM	Relative water Content	-4	Shoot	*Cicer arietinum L.*	72	69	32
100 µM		-11			72	64	
150 µM		-26			72	53	
200 µM		-44			72	40	
500 µM	Dry weight	-57	shoot	*Spinacia oleracea L.*	2.85	1.23	33
		-91			3.32	0.29	
5 mg/kg	Length of plant	2	Shoot	*Vicia faba L.*	50	51	14
10 mg/kg		12			50	56	
15 mg/kg		30			50	65	
20 mg/kg		30			50	65.1	
5 mg/kg	Length of plant	5	Shoot	*Vicia faba L.*	49	51.4	14
10 mg/kg		14			49	56	
15 mg/kg		33			49	65	
20 mg/kg		35			49	66	
5 ppm	Dry weight	41	Shoot	*Vicia faba L.*	10.25	14.5	14
10 ppm		85			10.25	18.97	
15 ppm		147			10.25	25.3	
20 ppm		156			10.25	26.2	
5 ppm	Dry weight	48	Shoot	*Vicia faba L.*	10.12	15	14
10 ppm		95			10.12	19.72	

15 ppm		158			10.12	26.15	
20 ppm		169			10.12	27.24	
2.5 mg/kg	Leaf Area	6	shoot	*Moringa oleifera*	1037	1103	34
5 mg/kg		17			1037	1215	
7.5 mg/kg		29			1037	1334	
10 mg/kg		27			1037	1312	
12.5 mg/kg		29			1037	1340	
15 mg/kg		17			1037	1215	
2.5 mg/kg	Length	4	shoot	*Moringa oleifera*	74.8	78	34
5 mg/kg		8			74.8	80.41	
7.5 mg/kg		26			74.8	94	
10 mg/kg		15			74.8	86	
12.5 mg/kg		22			74.8	91	
15 mg/kg		17			74.8	87.6	
2.5 mg/kg	Dry weight	7	shoot	*Moringa oleifera*	60.9	65	34
5 mg/kg		10			60.9	67	
7.5 mg/kg		29			60.9	78.7	
10 mg/kg		17			60.9	71	
12.5 mg/kg		19			60.9	72.3	
15 mg/kg		14			60.9	69.3	
5 mg/kg	Height	1	Shoot	*Ipomoea batatas L*	225	228	15
7.5 mg/kg		3			225	232	
10 mg/kg		7			225	241	
12.5 mg/kg		5			225	237	
15 mg/kg		4			225	234	
5 mg/kg	Fresh weight	1	Shoot	*Ipomoea batatas L*	434	438	15
7.5 mg/kg		2			434	441	
10 mg/kg		3			434	448	
12.5 mg/kg		1			434	440	
15 mg/kg		1			434	437	
5 mg/kg	Dry weight	1	Shoot	*Ipomoea batatas L*	270	274	15
7.5 mg/kg		2			270	276	
10 mg/kg		4			270	280	
12.5 mg/kg		2			270	276	
15 mg/kg		1			270	274	
10 µg/L	Length	0	Shoot	*Cicer arietinum*	26.8	26.8	35
50 µg/L		-2			26.8	26.26	
100 µg/L		-7			26.8	25	
200 µg/L		-5			26.8	25.4	
400 µg/L		-14			26.8	23	
10 µg/L	Fresh weight	0	Shoot	*Cicer arietinum*	8	8	35
50 µg/L		-1			8	7.93	
100 µg/L		-3			8	7.8	

200 μg/L		-6			8	7.53	
400 μg/L		-12			8	7.04	
10 μg/L	Dry weight	0	Shoot	*Cicer arietinum*	2.77	2.77	35
50 μg/L		-6			2.77	2.59	
100 μg/L		-14			2.77	2.37	
200 μg/L		-15			2.77	2.35	
400 μg/L		-17			2.77	2.31	
10 μg/L	yield	-1	Shoot	*Cicer arietinum*	27	26.73	35
50 μg/L		-1			27	26.79	
100 μg/L		-3			27	26.11	
200 μg/L		-6			27	25.46	
400 μg/L		-7			27	25.2	
15 mg/L	Dry weight	4	Shoot	*Cucumis sativus L.*	85.5	88.6	36
20 mg/L		4			85.5	88.9	
15 mg/L	Yield	20	Shoot	*Cucumis sativus L.*	2839	3403	
20 mg/L		-3			2839	2745	
0.05 g/L	Seedling FW	11	Shoot	Canola	0.085	0.094	37
0.1 g/L		6			0.085	0.09	
0.25 g/L		-8			0.085	0.078	
0.5 g/L		-26			0.085	0.063	
1 g/L		-32			0.085	0.058	
2 g/L		-58			0.085	0.036	
4 g/L		-61			0.085	0.033	
0.05 g/L	Seedling DW	8	Shoot	Canola	0.0051	0.0055	37
0.1 g/L		2			0.0051	0.0052	
0.25 g/L		-10			0.0051	0.0046	
0.5 g/L		-18			0.0051	0.0042	
1 g/L		-35			0.0051	0.0033	
2 g/L		-37			0.0051	0.0032	
4 g/L		-53			0.0051	0.0024	
0.05 g/L	Radicle length	10	Shoot	Canola	9	9.9	37
0.1 g/L		13			9	10.2	
0.25 g/L		-8			9	8.3	
0.5 g/L		-30			9	6.3	
1 g/L		-43			9	5.1	
2 g/L		-50			9	4.5	
4 g/L		-72			9	2.5	
0.05 g/L	Plumule length	11	Shoot	Canola	5.6	6.2	37
0.1 g/L		4			5.6	5.8	
0.25 g/L		-7			5.6	5.2	
0.5 g/L		-23			5.6	4.3	
1 g/L		-29			5.6	4	
2 g/L		-52			5.6	2.7	

4 g/L		-64			5.6	2	
0.05 g/L		10			14.6	16.1	
0.1 g/L		10			14.6	16.1	
0.25 g/L		-8			14.6	13.5	
0.5 g/L	Seedling length	-27	Shoot	Canola	14.6	10.6	37
1 g/L		-38			14.6	9.1	
2 g/L		-50			14.6	7.3	
4 g/L		-68			14.6	4.6	
7.5 g/L	Weight of ears	60	Shoot	Maize	100	160	26
7.5 g/L		29			140	180	
7.5 g/L	Plant height	7	Shoot	Maize	140	150	26
7.5 g/L		7			150	160	26
7.5 g/L	Grain yield	9	Grain	Maize	5500	6000	26
7.5 g/L		15			6500	7500	26
7.5 g/L	Water use efficiency	23	Leaves	Maize	0.65	0.8	26
7.5 g/L		11			0.9	1	26
7.5 g/L	Shoot fresh weight	17	Shoot	Maize	300	350	26
7.5 g/L	Seed weight	94	Seed		18	35	
7.5 g/L	Pods weight	43	Pods	Maize	28	40	
50 mM	Root length	-25	Root	*Phaseolus vulgaris*	32	24	38
50 mM	Shoot height	-26	Shoot		38	28	
50 mM	Shoot water content	-2	Shoot		88	86	
50 mM	Leaflet ar	220	Leaf		25	80	
25 µM	Shoot length	12	Leaf	*Hydrilla verticillata*	4.96	5.57	39
50 µM	Shoot length	-10	Leaf		4.96	4.48	
75 µM	Shoot length	-19	Leaf		4.96	4.03	
100 µM	Shoot length	-33	Leaf		4.96	3.34	
20 mg/kg	Shoot biomass	-30.7	Leaf	Pakchois	6.5	4.5	40
40 mg/kg	Shoot biomass	-15.3	Leaf		6.5	5.5	

Table S3: Percent variation in different growth variables of plant roots in response to Co

Co dose	Growth	% change	Organ	Plant species	Control Values	Co-treated Value	Reference
7.5 mg/L	Root Length	66.6	Root		9	15	
7.5 mg/L	Root Length	50	Root	Peanuts	12	18	[26]
7.5 mg/L	Root Length	40	Root		10	14	
10 mg/L	Root fresh weight	28	Shoot	*Tagestes eracta*	5.8	7.4	
20 mg/L		-19	Shoot	*Tagestes eracta*	5.8	4.7	[27]
10 mg/L	Root dry weight	39	Roots	*Tagestes eracta*	3.8	5.3	
20 mg/L		-26	Roots	*Tagestes eracta*	3.8	2.8	[27]
50 µM	Dry weight	-75	Root	Barley	29.41	7.47	[12]
50 µM	Tissue length	-78			45.81	10.25	[12]
2 mM	Tissue length	-16	Root	*Eleusine coracana (L.)*	9.46	7.933	[28]
4 mM		-27			9.46	6.933	
6 mM		-32			9.46	6.433	
8 mM		-39			9.46	5.733	
10 mM		-50			9.46	4.76	
50 µM	Fresh weight	6	Root	*Triticum aestivum L.*	1.37	1.45	[29]
150 µM		-38			1.37	0.85	
250 µM		-62			1.37	0.52	
350 µM		-80			1.37	0.28	
50 µM	Dry weight	3	Root	*Triticum aestivum L.*	0.3	0.31	[29]
150 µM		-27			0.3	0.22	
250 µM		-37			0.3	0.19	
350 µM		-63			0.3	0.11	
50 µM	Water content	-5	Root	*Triticum aestivum L.*	83	79	[29]

150 µM		-11			83	74	
250 µM		-24			83	63	
350 µM		-40			83	50	
50 µM		23			24.52	30.14	
100µM		-9			24.52	22.43	
150 µM	Length	-20	Root	*Raphanus sativus L*	24.52	19.61	30
200 µM		-33			24.52	16.39	
250 µM		-44			24.52	13.62	
3 ppm		11			36.9	41	
6 ppm	Fresh weight	25	Root	*Brassica oleraceae L.*	36.9	46.2	31
9 ppm		17			36.9	43	
12 ppm		15			36.9	42.3	
3 ppm		11			9.55	10.6	
6 ppm	Dry weight	11	Root	*Brassica oleraceae L.*	9.55	15.3	31
9 ppm		60			9.55	12.8	
12 ppm		34			9.55	10.9	
500 µM	Dry weight	-64	Root	*Spinacia oleracea L.*	0.88	0.32	33
		-68			0.92	0.29	
5 ppm		34			14.95	20	
10 ppm	Dry weight	67	Root	*Vicia faba L.*	14.95	25	14
15 ppm		121			14.95	33	
20 ppm		127			14.95	34	
5 ppm		40			15	21	
10 ppm	Dry weight	73	Root	*Vicia faba L.*	15	26	14
15 ppm		133			15	35	
20 ppm		140			15	36	
5 mg/kg		14			16.1	18.4	
7.5 mg/kg		34			16.1	21.6	
10 mg/kg	Diameter	49	Root	*Ipomoea batatas L*	16.1	24	15
12.5 mg/kg		34			16.1	21.5	
15 mg/kg		19			16.1	19.2	
5 mg/kg		20			10.8	12.99	
7.5 mg/kg		40			10.8	15.1	
10 mg/kg	Yield	54	Root	*Ipomoea batatas L*	10.8	16.61	15
12.5 mg/kg		51			10.8	16.32	
15 mg/kg		46			10.8	15.76	
10 µg/L		0			21.3	21.3	
50 µg/L		0			21.3	21.2	
100 µg/L	Length	-1	Root	*Cicer arietinum*	21.3	21	35
200 µg/L		-7			21.3	19.8	
400 µg/L		-10			21.3	19.2	
10 µg/L	Fresh weight	0	Root	*Cicer arietinum*	6.42	6.42	35
50 µg/L		0			6.42	6.41	

100 µg/L		-2			6.42	6.26	
200 µg/L		-2			6.42	6.28	
400 µg/L		-7			6.42	6	
10 µg/L		-4			1.68	1.62	
50 µg/L		-4			1.68	1.61	
100 µg/L	Dry weight	-10	Root	*Cicer arietinum*	1.68	1.52	35
200 µg/L		-20			1.68	1.34	
400 µg/L		-29			1.68	1.19	
0.05 g/L		11			88	98	
0.1 g/L		9			88	96	
0.25 g/L		-7			88	82	
0.5 g/L	Germination percentage	-14	Root	Canola	88	76	37
1 g/L		-31			88	61	
2 g/L		-43			88	50	
4 g/L		-49			88	45	
0.05 g/L		1			15.8	16	
0.1 g/L		1			15.8	15.9	
0.25 g/L		-7			15.8	14.7	
0.5 g/L	Germination rate	-8	Root	Canola	15.8	14.5	37
1 g/L		-15			15.8	13.4	
2 g/L		-28			15.8	11.3	
4 g/L		-34			15.8	10.4	
3 g/L	Root length	18	Root	Peanut	11	13	
3 g/L		17			6	7	23
3 g/L	Oil contents	5	Seed	Peanut	40	42	
3 g/L		7			45	48	
3 g/L	Protein contents	8	Seed	Peanut	25	27	
3 g/L		8			26	28	
3 g/L	Carbohydrate	-50	Seed	Peanut	1.2	0.6	23
3 g/L		-50			1.5	0.75	
3 g/L	Seed yield	5	Seed	Peanut	2100	2200	
3 g/L		8			2600	2800	
7.5 g/L	Root length	10	Root	Groundnut	10	11	26
50 mM	Root length	-25	Root	*Phaseolus vulgaris*	32	24	38

Table S4: Positive and negative effects of low and high levels of cobalt on different growth variables of plant.

Co dose	Growth	% change	Organ	Plant species	Control Values	Co-treated Value	Reference
10 mg/L	Shoot dry weight	88	Shoot	*Tagestes eracta*	5.6	10.5	[27]
20 mg/L		-30	Shoot	*Tagestes eracta*	5.6	3.9	
10 mg/L	Flower fresh weight	15	Shoot	*Tagestes eracta*	8.2	9.4	[27]
20 mg/L		-32	Shoot	*Tagestes eracta*	8.2	5.6	
10 mg/L	Flower dry weight	11	Roots	*Tagestes eracta*	12.8	14.2	[27]
20 mg/L		-22	Roots	*Tagestes eracta*	12.8	10	
10 mg/L	Leaf area	36	Shoot	*Tagestes eracta*	14.3	19.4	[27]
20 mg/L		-8	Shoot	*Tagestes eracta*	14.3	13.2	
10 mg/L	Flower diameter	18	Roots	*Tagestes eracta*	15.2	17.9	[27]
20 mg/L		-57	Roots	*Tagestes eracta*	15.2	6.5	
10 mg/L	Shoot dry weight	88	Shoot	*Tagestes eracta*	5.6	10.5	[27]
20 mg/L		-30	Shoot	*Tagestes eracta*	5.6	3.9	
2 mM	Leaf area	-7	shoot	*Eleusine coracana (L.)*	4.33	4.033	[28]

4 mM		-18		*Eleusine coracana (L.)*	4.33	3.533	
6 mM		127		*Eleusine coracana (L.)*	4.33	9.85	
8 mM		120		*Eleusine coracana (L.)*	4.33	9.52	
10 mM		85		*Eleusine coracana (L.)*	4.33	8.02	
50 µM	Shoot Height	4	Shoot	*Triticum aestivum L.*	18.5	19.2	
150 µM		-22		*Triticum aestivum L*	18.5	14.4	29
250 µM		-48		*Triticum aestivum L*	18.5	9.7	
350 µM		-67		*Triticum aestivum L*	18.5	6.1	
50 µM	Leaf Area	10	Shoot	*Raphanus sativus L*	58.72	64.44	
100µM		-6		*Raphanus sativus L*	58.72	55.35	
150 µM		-20		*Raphanus sativus L*	58.72	47.16	30
200 µM		-32		*Raphanus sativus L*	58.72	39.67	
250 µM		-46		*Raphanus sativus L*	58.72	31.45	
50 µM	Length	10	Shoot	*Raphanus sativus L*	10.42	11.44	30
100µM		-19		*Raphanus sativus L*	10.42	8.45	

150 µM		-31		*Raphanus sativus L*	10.42	7.19	
200 µM		-35		*Raphanus sativus L*	10.42	6.74	
3 ppm	Dry weight	11	Shoot	*Brassica oleraceae L.*	46.6	51.7	
6 ppm		-83		*Brassica oleraceae L*	336	58	31
9 ppm		-84		*Brassica oleraceae L*	336	54.8	
12 ppm		-84		*Brassica oleraceae L*	336	53.7	
15 mg/L	Yield	20	Shoot	*Cucumis sativus L.*	2839	3403	36
20 mg/L		-3		*Cucumis sativus L.*	2839	2745	
0.05 g/L	Seedling FW	8	Shoot	Canola	0.085	0.063	
0.1 g/L	Seedling FW	2	Shoot	Canola	0.085	0.058	37
0.25 g/L	Seedling FW	-10	Shoot	Canola	0.085	0.036	
0.05 g/L	Radicle length	11	Shoot	Canola	5.6	6.2	
0.1 g/L	Radicle length	4	Shoot	Canola	5.6	5.8	37
0.25 g/L	Radicle length	-7	Shoot	Canola	5.6	5.2	
25 µM	Shoot length	12	Leaf	Hydrilla verticillata	4.96	5.57	39

50 µM	Shoot length	-10	Leaf	Hydrilla verticillata	4.96	4.48	
75 µM	Shoot length	-19	Leaf	Hydrilla verticillata	4.96	4.03	
100 µM	Shoot length	-33	Leaf	Hydrilla verticillata	4.96	3.34	
10 mg/L	Root fresh weight	28	Shoot	Tagestes eracta	5.8	7.4	27
20 mg/L		-19	Shoot	Tagestes eracta	5.8	4.7	
10 mg/L	Root dry weight	39	Roots	Tagestes eracta	3.8	5.3	27
20 mg/L		-26	Roots	Tagestes eracta	3.8	2.8	
50 µM	Fresh weight	6	Root	Triticum aestivum L.	1.37	1.45	
150 µM		-38		Triticum aestivum L.	1.37	0.85	29
250 µM		-62		Triticum aestivum L.	1.37	0.52	
350 µM		-80		Triticum aestivum L.	1.37	0.28	
50 µM	Dry weight	3	Root	Triticum aestivum L.	0.3	0.31	
150 µM		-27		Triticum aestivum L.	0.3	0.22	29
250 µM		-37		Triticum aestivum L.	0.3	0.19	
350 µM		-63		Triticum aestivum L.	0.3	0.11	

50 µM	Length	23	Root	Raphanus sativus L	24.52	30.14	
100µM		-9		Raphanus sativus L	24.52	22.43	
150 µM		-20		Raphanus sativus L	24.52	19.61	30
200 µM		-33		Raphanus sativus L	24.52	16.39	
250 µM		-44		Raphanus sativus L	24.52	13.62	
0.05 g/L	Germination percentage	11	Root	Canola	88	98	
0.1 g/L		9		Canola	88	96	37
0.25 g/L		-7		Canola	88	82	
0.5 g/L		-14		Canola	88	76	
50 µM		22	shoot		0.719	0.876	
100µM		-10	shoot		0.719	0.648	
150 µM	Chl-a	-28	shoot	*Vigna radiata (L.)*	0.719	0.517	41
200 µM		-41	shoot		0.719	0.426	
250 µM		-58	shoot		0.719	0.302	
50 µM		72	shoot		1.143	1.964	
100µM		-11	shoot		1.143	1.012	
150 µM	Chl-b	-31	shoot	*Vigna radiata (L.)*	1.143	0.785	41
200 µM		-41	shoot		1.143	0.673	
250 µM		-65	shoot		1.143	0.397	
50 µM		53	shoot		1.862	2.84	
100µM		-11	shoot		1.862	1.66	
150 µM	Total Chl	-25	shoot	*Vigna radiata (L.)*	1.862	1.392	41
200 µM		-41	shoot		1.862	1.099	
250 µM		-62	shoot		1.862	0.699	
50 µM	Car	42	shoot	*Vigna radiata (L.)*	0.093	0.132	41
100µM		-8	shoot		0.093	0.086	

150 µM		-31	shoot		0.093	0.064	
200 µM		-55	shoot		0.093	0.042	
250 µM		-60	shoot		0.093	0.037	
50 µM	Chl-b	4	Shoot	*Triticum aestivum L.*	1.4	1.45	29
150 µM		-40			1.4	0.84	
250 µM		-47			1.4	0.74	
350 µM		-71			1.4	0.41	
50 µM	Car	31	Shoot	*Triticum aestivum L.*	0.65	0.85	29
150 µM		-26			0.65	0.48	
250 µM		-52			0.65	0.31	
350 µM		-60			0.65	0.26	
50 µM	Total Chl	3	shoot	*Cicer arietinum L.*	1.25	1.29	32
100 µM		-15			1.25	1.06	
150 µM		-18			1.25	1.02	
200 µM		-42			1.25	0.73	
250 µM		-60			1.25	0.5	
0.5 ppm		9			7.05	7.68	
1 ppm		28			7.05	9.04	
2 ppm		-24			7.05	5.37	
3 ppm		-39			7.05	4.28	
0.1 ppm	Car	3	shoot	*Monoraphidium minutum*	2.82	2.91	42
0.5 ppm		7			2.82	3.02	
1 ppm		-6			2.82	2.66	
2 ppm		-15			2.82	2.4	
3 ppm		-39			2.82	1.71	
0.5 ppm	Chl-a	4	shoot	*Nitzchia perminuta*	2.5	2.61	42
1.5 ppm		12			2.5	2.81	
2.5 ppm		-4			2.5	2.4	
3.5 ppm		-29			2.5	1.78	
5 ppm		-36			2.5	1.6	
10 µg/L	Chl-a	0	shoot	*Cicer arietinum*	0.648	0.648	35
50 µg/L		0			0.648	0.645	
100 µg/L		-1			0.648	0.64	
200 µg/L		-4			0.648	0.622	
400 µg/L		-4			0.648	0.62	
10 µg/L	Chl-b	0	shoot	*Cicer arietinum*	0.541	0.541	35
50 µg/L		0			0.541	0.539	
100 µg/L		-1			0.541	0.533	
200 µg/L		-4			0.541	0.522	
400 µg/L		-5			0.541	0.513	
10 µg/L	Total Chl	0	shoot	*Cicer arietinum*	1.193	1.193	35
50 µg/L		0			1.193	1.19	
100 µg/L		-1			1.193	1.186	

200 µg/L		-1			1.193	1.183	
400 µg/L		-1			1.193	1.176	
1 g/L		-31		Canola	88	61	
2 g/L		-43		Canola	88	50	
4 g/L		-49		Canola	88	45	
0.05 g/L	Germination rate	1	Root	Canola	15.8	16	
0.1 g/L		1		Canola	15.8	15.9	
0.25 g/L		-7		Canola	15.8	14.7	
0.5 g/L		-8		Canola	15.8	14.5	37
1 g/L		-15		Canola	15.8	13.4	
2 g/L		-28		Canola	15.8	11.3	
4 g/L		-34		Canola	15.8	10.4	

Table S5: Percent variation in plants pigment contents in response to Co.

Co dose	Growth	% change	Organ	Plant species	Control Values	Co-treated Value	Reference
300 µM	Car	5	Leaf	Wheat	—	—	43
0.11 mg/L	Chl-a	-14.2	Leaf		1.4	1.2	
0.32 mg/L	Chl-a	-64.2	Leaf	*Raphidocelis subcapitata*	1.4	0.5	25
0.54 mg/L	Chl-a	-71.4	Leaf		1.4	0.4	
0.11 mg/L	Car	-17.1	Leaf		0.35	0.29	
0.32 mg/L	Car	-51.4	Leaf	*Raphidocelis subcapitata*	0.35	0.17	25
0.54 mg/L	Car	-68.5	Leaf		0.35	0.11	
200 µM	Chl-a	-52	Shoot	*Lactuca sativa L*	0.617	0.299	16
	Chl-b	-73	Shoot		0.218	0.059	
	Total Chl	-57	Shoot		0.835	0.357	
	Car	-48	Shoot		0.45	0.234	
50 µM	Chl-a	22	shoot	*Vigna radiata (L.)*	0.719	0.876	41
100µM		-10	shoot		0.719	0.648	
150 µM		-28	shoot		0.719	0.517	
200 µM		-41	shoot		0.719	0.426	
250 µM		-58	shoot		0.719	0.302	
50 µM	Chl-b	72	shoot	*Vigna radiata (L.)*	1.143	1.964	41
100µM		-11	shoot		1.143	1.012	
150 µM		-31	shoot		1.143	0.785	
200 µM		-41	shoot		1.143	0.673	
250 µM		-65	shoot		1.143	0.397	
50 µM	Total Chl	53	shoot	*Vigna radiata (L.)*	1.862	2.84	41
100µM		-11	shoot		1.862	1.66	
150 µM		-25	shoot		1.862	1.392	

200 µM		-41	shoot		1.862	1.099	
250 µM		-62	shoot		1.862	0.699	
50 µM		42	shoot		0.093	0.132	
100µM		-8	shoot		0.093	0.086	
150 µM	Car	-31	shoot	*Vigna radiata (L.)*	0.093	0.064	41
200 µM		-55	shoot		0.093	0.042	
250 µM		-60	shoot		0.093	0.037	
500 µM	Total Chl	-65	shoot	*Spinacia oleracea L.*	100	35	33
500 µM	Car	-65	shoot	*Spinacia oleracea L.*	100	35	33
100 µM	Chl-a	-26	Shoot	*Salix babylonica*	1.35	1	44
100 µM	Chl-b	-36	Shoot	*Salix babylonica*	0.7	0.45	44
100 µM		-16	Shoot		1.86	1.56	
101 µM	Total Chl	-39	Shoot	*Brassica junceaL.*	2.48	1.52	45
102 µM		-65	Shoot		2.92	1.02	
50 µM		-3			3.11	3.03	
150 µM	Chl-a	-21	Shoot	*Triticum aestivum L.*	3.11	2.47	29
250 µM		-72			3.11	0.87	
350 µM		-81			3.11	0.6	
50 µM		4			1.4	1.45	
150 µM	Chl-b	-40	Shoot	*Triticum aestivum L.*	1.4	0.84	29
250 µM		-47			1.4	0.74	
350 µM		-71			1.4	0.41	
50 µM		31			0.65	0.85	
150 µM	Car	-26	Shoot	*Triticum aestivum L.*	0.65	0.48	29
250 µM		-52			0.65	0.31	
350 µM		-60			0.65	0.26	
500 µM	Total Chl	-70	shoot	*Spinacia oleracea L.*	100	30	33
50 µM		3			1.25	1.29	
100 µM		-15			1.25	1.06	
150 µM	Total Chl	-18	shoot	*Cicer arietinum L.)*	1.25	1.02	32
200 µM		-42			1.25	0.73	
250 µM		-60			1.25	0.5	
0.1 ppm		7			8.02	8.57	
0.5 ppm		29			8.02	10.35	
1 ppm	Chl-a	-25	shoot	*Monoraphidium minutum*	8.02	6.03	42
2 ppm		-38			8.02	4.98	
3 ppm		-46			8.02	4.35	
0.1 ppm		0			7.05	7.05	
0.5 ppm		9			7.05	7.68	
1 ppm	Chl-b	28	shoot	*Monoraphidium minutum*	7.05	9.04	42
2 ppm		-24			7.05	5.37	
3 ppm		-39			7.05	4.28	

0.1 ppm	Car	3	shoot	*Monoraphidium minutum*	2.82	2.91	42
0.5 ppm		7			2.82	3.02	
1 ppm		-6			2.82	2.66	
2 ppm		-15			2.82	2.4	
3 ppm		-39			2.82	1.71	
0.5 ppm	Chl-a	4	shoot	*Nitzchia perminuta*	2.5	2.61	42
1.5 ppm		12			2.5	2.81	
2.5 ppm		-4			2.5	2.4	
3.5 ppm		-29			2.5	1.78	
5 ppm		-36			2.5	1.6	
10 ppm	Chl-a	38	shoot	Paulownia	0.4	0.55	46
20 ppm		68			0.4	0.67	
30 ppm		85			0.4	0.74	
40 ppm		133			0.4	0.93	
50 ppm		115			0.4	0.86	
60 ppm		25			0.4	0.5	
10 ppm	Chl-b	47	shoot	Paulownia	0.15	0.22	46
20 ppm		67			0.15	0.25	
30 ppm		80			0.15	0.27	
40 ppm		153			0.15	0.38	
50 ppm		113			0.15	0.32	
60 ppm		40			0.15	0.21	
10 ppm	Car	11	shoot	Paulownia	0.27	0.3	46
20 ppm		-15			0.27	0.23	
30 ppm		4			0.27	0.28	
40 ppm		37			0.27	0.37	
50 ppm		11			0.27	0.3	
60 ppm		7			0.27	0.29	
20 µM	Total Chl	-82	Shoot	*Lippia filifolia*	0.573	0.105	47
40 µM		-90			0.573	0.055	
60 µM		-94			0.573	0.033	
20 µM	car	778	Shoot	*Lippia filifolia*	0.185	1.625	47
40 µM		644			0.185	1.377	
60 µM		1587			0.185	3.121	
2 mM	Chl-a	0	shoot	*Eleusine coracana (L.)*	16.49	16.44	28
4 mM		-8			16.49	15.25	
6 mM		-17			16.49	13.61	
8 mM		-24			16.49	12.54	
10 mM		-36			16.49	10.61	
2 mM	Chl-b	-28	shoot	*Eleusine coracana (L.)*	13.39	9.63	28
4 mM		-35			13.39	8.7	
6 mM		-50			13.39	6.67	
8 mM		-66			13.39	4.57	

10 mM		-69			13.39	4.21	
2 mM	Total Chl	-14	shoot	*Eleusine coracana (L.)*	31.22	26.75	28
4 mM		-22			31.22	24.29	
6 mM		-33			31.22	20.95	
8 mM		-43			31.22	17.78	
10 mM		-55			31.22	14.01	
2 mM	Car	-18	shoot	*Eleusine coracana (L.)*	0.22	0.18	28
4 mM		-27			0.22	0.16	
6 mM		-41			0.22	0.13	
8 mM		-55			0.22	0.1	
10 mM		-59			0.22	0.09	
10 µg/L	Chl-a	0	shoot	*Cicer arietinum*	0.648	0.648	35
50 µg/L		0			0.648	0.645	
100 µg/L		-1			0.648	0.64	
200 µg/L		-4			0.648	0.622	
400 µg/L		-4			0.648	0.62	
10 µg/L	Chl-b	0	shoot	*Cicer arietinum*	0.541	0.541	35
50 µg/L		0			0.541	0.539	
100 µg/L		-1			0.541	0.533	
200 µg/L		-4			0.541	0.522	
400 µg/L		-5			0.541	0.513	
10 µg/L	Total Chl	0	shoot	*Cicer arietinum*	1.193	1.193	35
50 µg/L		0			1.193	1.19	
100 µg/L		-1			1.193	1.186	
200 µg/L		-1			1.193	1.183	
400 µg/L		-1			1.193	1.176	
0.22 µM	Chl-a	0	shoot	*Raphidocelis subcapitata*	0.15	0.15	48
0.44 µM		20			0.15	0.18	
0.67 µM		40			0.15	0.21	
0.89 µM		60			0.15	0.24	
1.11 µM		53			0.15	0.23	
0.98 µM	Chl-a	13	shoot	*Raphidocelis subcapitata*	0.15	0.17	48
1.83 µM		7			0.15	0.16	
2.67 µM		17			0.15	0.175	
3.53 µM		40			0.15	0.21	
4.37 µM		53			0.15	0.23	
0.98 µM	Chl-a	13	shoot	*Raphidocelis subcapitata*	0.15	0.17	48
1.83 µM		7			0.15	0.16	
2.67 µM		17			0.15	0.175	
3.53 µM		40			0.15	0.21	
4.37 µM		53			0.15	0.23	
0.98 µM	Chl-a	13	shoot	*Raphidocelis subcapitata*	0.15	0.17	48
1.83 µM		7			0.15	0.16	

2.67 µM		17			0.15	0.175	
3.53 µM		40			0.15	0.21	
4.37 µM		53			0.15	0.23	
400 µM	Chl-a	-79			6.1	1.3	
400 µM	Chl-b	-68	Shoot	*Solanum lycopersicum L.*	19	6	[49]
400 µM	Car	-46			3.25	1.75	
3 g/L	Chl	4	Leaves	Peanut	41	42.5	[23]
3 g/L		2			42	43	
3 g/L	Chl	2	Leaves	Peanut	42	43	[23]
3 g/L		2			42.5	43.5	
3 g/L	Chl	4	Leaves	Peanut	75	78	[23]
3 g/L		3			80	82	
3 g/L	Chl	4	Leaves	Peanut	76	79	[23]
3 g/L		1			81	82	
50 mM	Chl-a	-23			1.3	1	
50 mM	Chl-b	-43	Leaf	*Phaseolus vulgaris*	0.49	0.28	[38]
50 mM	Car	43			0.35	0.5	
25 µM	Total Chl	5	Leaf		0.63	0.66	
50 µM	Total Chl	-8	Leaf	*Hydrilla verticillata*	0.63	0.58	[39]
75 µM	Total Chl	-13	Leaf		0.63	0.55	
100 µM	Total Chl	-19	Leaf		0.63	0.51	
25 µM	Chl-a	3	Leaf		0.35	0.36	
50 µM	Chl-a	-9	Leaf	*Hydrilla verticillata*	0.35	0.32	[39]
75 µM	Chl-a	-3	Leaf		0.35	0.34	
100 µM	Chl-a	-17	Leaf		0.35	0.29	
25 µM	Chl-b	11	Leaf		0.27	0.3	
50 µM	Chl-b	-7	Leaf	*Hydrilla verticillata*	0.27	0.25	[39]
75 µM	Chl-b	-15	Leaf		0.27	0.23	
100 µM	Chl-b	-22	Leaf		0.27	0.21	
25 µM	Car	0	Leaf		0.25	0.25	
50 µM	Car	0	Leaf	*Hydrilla verticillata*	0.25	0.25	[39]
75 µM	Car	4	Leaf		0.25	0.26	
100 µM	Car	4	Leaf		0.25	0.26	

Table S6: The effect of Co on accumulation of different macronutrients.

Co dose	Nutrients	% change	Organ	Plant species	Control Values	Co-treated Value	Reference
3 g/L	N	10	Leaves	Peanut	50000	55000	[23]
3 g/L		8			52000	56000	
3 g/L	P	5	Leaves	Peanut	21000	22000	[23]
3 g/L		5			21500	22500	
3 g/L	Ca	7	Leaves	Peanut	15000	16000	[23]
3 g/L		6			16000	17000	
3 g/L	K	4	Leaves	Peanut	25000	26000	[23]
3 g/L		6			24000	25500	
3 g/L	K	44	Roots	Peanut	4500	6500	[23]
3 g/L		13			5500	6200	
3 g/L	K	1	Seeds	Peanut	7800	7850	[23]
3 g/L		1			6800	6900	
7.5 g/L	N	2	Leaves	Maiz	13	13.2	[26]

7.5 g/L		15			13	15	
7.5 g/L	P	22	Leaves	Maiz	0.9	1.1	[26]
7.5 g/L		5			1.1	1.15	
7.5 g/L	K	2	Leaves	Maiz	4.5	4.6	[26]
7.5 g/L		1			4.6	4.65	
7.5 g/L	N	21	Leaves	Groundnut	48000	58000	[26]
7.5 g/L	P	12			26000	29000	
7.5 g/L	K	13			8000	9000	
10 mg/L	Na	-10	Shoot		20	18	
20 mg/L		-65	Shoot		20	7	
10 mg/L		-7	Roots	*Tagestes eracta*	28	26	[27]
20 mg/L		-21	Roots		28	22	
10 mg/L	Ca	19	Shoot		32	38	
20 mg/L		-6	Shoot	*Tagestes eracta*	32	30	[27]
10 mg/L		14	Roots		42	48	

20 mg/L		-10	Roots		42	38	
10 mg/L	K	28	Shoot		18	23	
20 mg/L		44	Shoot	*Tagestes eracta*	18	26	27
10 mg/L		9	Roots		22	24	
20 mg/L		-27	Roots		22	16	
2.5 mg/kg		5			2.6	2.73	
5 mg/kg		35			2.6	3.5	
7.5 mg/kg		50			2.6	3.89	
10 mg/kg	N	50	shoot	*Moringa oleifera*	2.6	3.89	34
12.5 mg/kg		43			2.6	3.72	
15 mg/kg		37			2.6	3.56	
2.5 mg/kg		41			0.17	0.24	
5 mg/kg		65			0.17	0.28	
7.5 mg/kg		88			0.17	0.32	
10 mg/kg	P	94	shoot	*Moringa oleifera*	0.17	0.33	34
12.5 mg/kg		88			0.17	0.32	
15 mg/kg		59			0.17	0.27	
2.5 mg/kg		27			0.95	1.21	
5 mg/kg		53			0.95	1.45	
7.5 mg/kg		71			0.95	1.62	
10 mg/kg	K	71	shoot	*Moringa oleifera*	0.95	1.62	34
12.5 mg/kg		68			0.95	1.6	
15 mg/kg		65			0.95	1.57	
50 µM		11			31.2	34.5	
100µM		-3			31.2	30.4	
150 µM	N	-8	Shoot	*Raphanus sativus L*	31.2	28.8	30
200 µM		-15			31.2	26.5	
250 µM		-23			31.2	24	
50 µM		15			8.4	9.7	
100µM		-10			8.4	7.6	
150 µM	P	-19	Shoot	*Raphanus sativus L*	8.4	6.8	30
200 µM		-27			8.4	6.1	

250 µM		-32			8.4	5.7	
50 µM	K	7	Shoot	*Raphanus sativus L*	40.3	43.1	30
100µM		-8			40.3	37.2	
150 µM		-12			40.3	35.5	
200 µM		-17			40.3	33.3	
250 µM		-23			40.3	31	
3 ppm	N	16	Shoot	*Brassica oleraceae L.*	1.58	1.83	31
6 ppm		102			1.58	3.19	
9 ppm		84			1.58	2.9	
12 ppm		20			1.58	1.89	
3 ppm	P	13	Shoot	*Brassica oleraceae L.*	0.256	0.288	31
6 ppm		21			0.256	0.311	
9 ppm		13			0.256	0.29	
12 ppm		8			0.256	0.276	
3 ppm	K	20	Shoot	*Brassica oleraceae L.*	1.63	1.95	31
6 ppm		48			1.63	2.41	
9 ppm		24			1.63	2.02	
12 ppm		16			1.63	1.89	
3 ppm	S	4	Shoot	*Brassica oleraceae L.*	0.791	0.821	31
6 ppm		39			0.791	1.102	
9 ppm		21			0.791	0.956	
12 ppm		12			0.791	0.883	
5 ppm	N	130	Shoot	*Vicia faba L.*	0.81	1.86	14
10 ppm		178			0.81	2.25	
15 ppm		321			0.81	3.41	
20 ppm		512			0.81	4.96	
5 ppm	P	18	Shoot	*Vicia faba L.*	0.11	0.13	14
10 ppm		-9			0.11	0.1	
15 ppm		64			0.11	0.18	
20 ppm		91			0.11	0.21	
5 ppm	K	25	Shoot	*Vicia faba L.*	0.68	0.85	14
10 ppm		43			0.68	0.97	
15 ppm		94			0.68	1.32	
20 ppm		115			0.68	1.46	
5 ppm	N	82	Root	*Vicia faba L.*	0.34	0.62	14
10 ppm		150			0.34	0.85	
15 ppm		397			0.34	1.69	
20 ppm		612			0.34	2.42	
5 ppm	P	75	Root	*Vicia faba L.*	0.04	0.07	14
10 ppm		175			0.04	0.11	
15 ppm		275			0.04	0.15	
20 ppm		350			0.04	0.18	
5 ppm	K	50	Root	*Vicia faba L.*	0.08	0.12	14

10 ppm		88			0.08	0.15	
15 ppm		175			0.08	0.22	
20 ppm		275			0.08	0.3	
5 mg/kg		2			1.26	1.28	
7.5 mg/kg		5			1.26	1.32	
10 mg/kg	N	8	shoot	*Ipomoea batatas L*	1.26	1.36	15
12.5 mg/kg		6			1.26	1.33	
15 mg/kg		4			1.26	1.31	
5 mg/kg		2			2.2	2.24	
7.5 mg/kg		5			2.2	2.3	
10 mg/kg	P	6	shoot	*Ipomoea batatas L*	2.2	2.34	15
12.5 mg/kg		5			2.2	2.31	
15 mg/kg		4			2.2	2.28	
5 mg/kg		2			1.26	1.29	
7.5 mg/kg		6			1.26	1.33	
10 mg/kg	K	10	shoot	*Ipomoea batatas L*	1.26	1.39	15
12.5 mg/kg		6			1.26	1.34	
15 mg/kg		3			1.26	1.3	
5 mg/kg		3			1.2	1.23	
7.5 mg/kg		5			1.2	1.26	
10 mg/kg	N	8	shoot	*Ipomoea batatas L*	1.2	1.3	15
12.5 mg/kg		6			1.2	1.27	
15 mg/kg		5			1.2	1.26	
5 mg/kg		2			2.25	2.3	
7.5 mg/kg		5			2.25	2.36	
10 mg/kg	P	8	shoot	*Ipomoea batatas L*	2.25	2.42	15
12.5 mg/kg		7			2.25	2.4	
15 mg/kg		5			2.25	2.37	
5 mg/kg		3			1.37	1.41	
7.5 mg/kg		7			1.37	1.46	
10 mg/kg	K	10	shoot	*Ipomoea batatas L*	1.37	1.51	15
12.5 mg/kg		6			1.37	1.45	
15 mg/kg		4			1.37	1.42	
100 µM	Ca	19	shoot	*Zea mays L.*	6.7	8	17
200 µM		72			6.7	11.5	
100 µM	K	-19	shoot	*Zea mays L.*	48	39	17
200 µM		-8			48	44	
100 µM	Mg	5	shoot	*Zea mays L.*	2.42	2.54	17
200 µM		47			2.42	3.56	
100 µM	Na	55	shoot	*Zea mays L.*	0.22	0.34	17

200 μM		127			0.22	0.5	
100 μM	Ca	-8	Root	*Zea mays L.*	13.7	12.6	17
200 μM		-11			13.7	12.2	
100 μM	K	-12	Root	*Zea mays L.*	35.2	31	17
200 μM		25			35.2	44	
100 μM	Mg	42	Root	*Zea mays L.*	4.14	5.89	17
200 μM		104			4.14	8.44	
100 μM	Na	80	Root	*Zea mays L.*	4.44	7.97	17
200 μM		50			4.44	6.66	

Table S7: The effect of Co on accumulation of different micronutrients.

Co dose	Nutrients	% change	Organ	Plant species	Control Values	Co-treated Value	Reference
3 g/L	Fe	-40	Seeds	Peanut	1000	600	23
3 g/L		-33			1500	1000	
3 g/L	Mn	-42	Seeds	Peanut	6000	3500	23
3 g/L		-38			6500	4000	
3 g/L	Zn	257	Seeds	Peanut	7	25	23
3 g/L		375			4	19	
7.5 g/L	Ca	108	Leaves	Groundnut	12	25	26
7.5 g/L	Fe	-35			310	200	
7.5 g/L	Mn	-54	Leaves	Groundnut	1300	600	26
7.5 g/L	Zn	13			16	18	
7.5 g/L	Cu	73			45	78	
2.5 mg/kg	Cu	7	shoot	*Moringa oleifera*	11.6	12.4	34
5 mg/kg		16			11.6	13.4	
7.5 mg/kg		23			11.6	14.3	
10 mg/kg		23			11.6	14.3	
12.5 mg/kg		20			11.6	13.9	
15 mg/kg		15			11.6	13.3	
2.5 mg/kg	Fe	-3	shoot	*Moringa oleifera*	277	268	34
5 mg/kg		-5			277	263	
7.5 mg/kg		-10			277	248	
10 mg/kg		-8			277	256	
12.5 mg/kg		-13			277	240	
15 mg/kg		-13			277	240	
2.5 mg/kg	Mn	7	shoot	*Moringa oleifera*	106	113	34
5 mg/kg		11			106	118	
7.5 mg/kg		18			106	125	
10 mg/kg		18			106	125	
12.5 mg/kg		14			106	121	
15 mg/kg		12			106	119	
2.5 mg/kg	Zn	3	shoot	*Moringa oleifera*	64	66	34
5 mg/kg		8			64	69	
7.5 mg/kg		11			64	71	
10 mg/kg		11			64	71	
12.5 mg/kg		8			64	69	
15 mg/kg		6			64	68	
50 µM	Cu	7	Shoot	*Raphanus sativus L*	27	29	30
100µM		-11			27	24	
150 µM		-22			27	21	
200 µM		-37			27	17	
250 µM		-48			27	14	
50 µM	Fe	7	Shoot	*Raphanus sativus L*	736	785	30
100µM		-3			736	713	

150 µM		-8			736	675	
200 µM		-14			736	634	
250 µM		-20			736	592	
50 µM	Mn	5	Shoot	*Raphanus sativus L*	41	43	[30]
100µM		-7			41	38	
150 µM		-17			41	34	
200 µM		-22			41	32	
250 µM		-29			41	29	
50 µM	Zn	5	Shoot	*Raphanus sativus L*	58	61	[30]
100µM		-3			58	56	
150 µM		-10			58	52	
200 µM		-19			58	47	
250 µM		-28			58	42	
3 ppm	Cu	9	Shoot	*Brassica oleraceae L.*	29.4	32	[31]
6 ppm		19			29.4	35	
9 ppm		26			29.4	37	
12 ppm		29			29.4	38	
3 ppm	Fe	-4	Shoot	*Brassica oleraceae L.*	163	156	[31]
6 ppm		-8			163	150	
9 ppm		-12			163	143	
12 ppm		-16			163	137	
3 ppm	Mn	4	Shoot	*Brassica oleraceae L.*	59.6	62	[31]
6 ppm		11			59.6	66	
9 ppm		12			59.6	67	
12 ppm		16			59.6	69	
3 ppm	Zn	9	Shoot	*Brassica oleraceae L.*	35	38	[31]
6 ppm		20			35	42	
9 ppm		24			35	43.3	
12 ppm		31			35	46	
5 mg/kg	Cu	2	Grain	*Triticum aestivum L.*	14.12	14.35	Kandil & El-Maghraby 2017
10 mg/kg		8			14.12	15.22	
15 mg/kg		6			14.12	14.98	
20 mg/kg		5			14.12	14.87	
25 mg/kg		-7			14.12	13.13	
5 mg/kg	Fe	-2	Grain	*Triticum aestivum L.*	121.41	119	Kandil & El-Maghraby 2017
10 mg/kg		-3			121.41	118	
15 mg/kg		-5			121.41	115	
20 mg/kg		-8			121.41	112	
25 mg/kg		-11			121.41	108	
5 mg/kg	Mn	6	Grain	*Triticum aestivum L.*	78.31	83	Kandil & El-Maghraby 2017
10 mg/kg		27			78.31	99.45	
15 mg/kg		26			78.31	98.64	
20 mg/kg		24			78.31	97.33	
25 mg/kg		21			78.31	95.1	
5 mg/kg	Zn	3	Grain	*Triticum aestivum L.*	13.15	13.57	Kandil & El-Maghraby 2017
10 mg/kg		8			13.15	14.24	
15 mg/kg		8			13.15	14.18	
20 mg/kg		2			13.15	13.39	
25 mg/kg		-5			13.15	12.52	
5 ppm	Cu	15	Shoot	*Vicia faba L.*	28	32.1	[14]
10 ppm		34			28	37.5	
15 ppm		44			28	40.2	
20 ppm		56			28	43.6	
5 ppm	Fe	68	Shoot	*Vicia faba L.*	40.6	68.4	[14]
10 ppm		53			40.6	62.1	
15 ppm		36			40.6	55.2	

20 ppm		18			40.6	48	
5 ppm		21			19.9	24	
10 ppm	Mn	37	Shoot	*Vicia faba L.*	19.9	27.3	14
15 ppm		63			19.9	32.5	
20 ppm		83			19.9	36.5	
5 ppm		17			15.5	18.1	
10 ppm	Zn	17	Shoot	*Vicia faba L.*	15.5	18.1	14
15 ppm		17			15.5	18.1	
20 ppm		17			15.5	18.1	
5 ppm		19			43	51.2	
10 ppm	Cu	33	Root	*Vicia faba L.*	43	57	14
15 ppm		37			43	59	
20 ppm		42			43	61	
5 ppm		162			48.5	127	
10 ppm	Fe	135	Root	*Vicia faba L.*	48.5	114	14
15 ppm		127			48.5	110	
20 ppm		84			48.5	89.2	
5 ppm		10			58	64	
10 ppm	Mn	19	Root	*Vicia faba L.*	58	69	14
15 ppm		27			58	73.7	
20 ppm		33			58	77	
5 ppm		44			25.5	36.6	
10 ppm	Zn	53	Root	*Vicia faba L.*	25.5	39	14
15 ppm		62			25.5	41.3	
20 ppm		78			25.5	45.5	
5 mg/kg		13			25.2	28.4	
7.5 mg/kg		29			25.2	32.6	
10 mg/kg	Cu	45	shoot	*Ipomoea batatas L*	25.2	36.5	15
12.5 mg/kg		37			25.2	34.4	
15 mg/kg		24			25.2	31.2	
5 mg/kg		-3			131.8	128	
7.5 mg/kg		-6			131.8	124	
10 mg/kg	Fe	-8	shoot	*Ipomoea batatas L*	131.8	121	15
12.5 mg/kg		-9			131.8	119.3	
15 mg/kg		-13			131.8	114.5	
5 mg/kg		-12			61.5	54.3	
7.5 mg/kg		14			61.5	70.4	
10 mg/kg	Mn	19	shoot	*Ipomoea batatas L*	61.5	73	15
12.5 mg/kg		14			61.5	70	
15 mg/kg		4			61.5	63.8	
5 mg/kg		8			30.2	32.6	
7.5 mg/kg		16			30.2	35	
10 mg/kg	Zn	28	shoot	*Ipomoea batatas L*	30.2	38.8	15
12.5 mg/kg		19			30.2	36	
15 mg/kg		9			30.2	33	
100 µM	Cu	-18	shoot	*Zea mays L.*	7.9	6.46	17
200 µM		18			7.9	9.36	
100 µM	Fe	-35	shoot	*Zea mays L.*	99.26	64.56	17
200 µM		24			99.26	123	
100 µM	Mn	-8	shoot	*Zea mays L.*	163	150	17
200 µM		53			163	250	
100 µM	Zn	11	shoot	*Zea mays L.*	45.63	50.5	17
200 µM		89			45.63	86.33	
100 µM	Cu	23	Root	*Zea mays L.*	11.98	14.76	17
200 µM		66			11.98	19.91	
100 µM	Fe	1376	Root	*Zea mays L.*	119	1757	17

200 μM		2316			119	2875	
100 μM	Mn	321	Root	*Zea mays L.*	53	223	17
200 μM		594			53	368	
100 μM	Zn	-12	Root	*Zea mays L.*	153	134	17
200 μM		87			153	286	

Table S8: Percent change in plants reactive oxygen species in response to Co**.**

Co dose	ROS	% change	Organ	Plant species	Control Values	Co-treated Value	Reference
300 µM	H_2O_2	10	Leaf	Wheat	––	––	50
10 mg/L	H_2O_2	-29	Shoot	*Tagestes eracta*	35	25	27
20 mg/L		71	Shoot		35	60	
10 mg/L		-8	Roots		38	35	
20 mg/L		29	Roots		38	49	
10 mg/L	O_2	-14	Shoot	*Tagestes eracta*	14	12	27
20 mg/L		21	Shoot		14	17	
10 mg/L		-23	Roots		22	17	
20 mg/L		50	Roots		22	33	
10 mg/L	OH	-9	Shoot	*Tagestes eracta*	35	32	27
20 mg/L		-17	Shoot		35	29	
10 mg/L		-5	Roots		41	39	
20 mg/L		5	Roots		41	43	
10 mg/L	Methylglyoxal	-17	Shoot	*Tagestes eracta*	12	10	27
20 mg/L		17	Shoot		12	14	
10 mg/L		-11	Roots		19	17	
20 mg/L		5	Roots		19	20	
200 µM	H_2O_2	127	Shoot	*Lactuca sativa L*	3.89	8.84	16
100 µM	H_2O_2	75	Shoot	*Brassica juncea L.*	1.42	2.48	45
		102	Shoot		2.48	5.02	45
		102	Shoot		5.06	10.2	45

100 µM	O_2	95	Shoot	*Brassica juncea L.*	0.42	0.82	45
		158	Shoot		0.96	2.48	45
		162	Shoot		1.2	3.14	45
50 µM	H_2O_2	3	Shoot	*Triticum aestivum L.*	16.5	17	29
150 µM		173			16.5	45	29
250 µM		258			16.5	59	29
350 µM		352			16.5	74.5	29
150 µM	H_2O_2	62	Leaves	*Triticum aestivum L.*	3.4	5.5	51
300 µM		82	Leaves		3.4	6.2	51
500 µM	H_2O_2	-31	Leaves	*Salvia officinalis L.*	16.39	11.38	52
50 mg/L	H_2O_2	-7	shoot	*BRASSICA NAPUS L.*	10.5	9.8	53
100 mg/L		-8			10.5	9.7	53
250 mg/L		14			10.5	12.0	53
500 mg/L		38			10.5	14.5	53
1000 mg/L		41			10.5	14.8	53
2000 mg/L		76			10.5	18.5	53
4000 mg/L		115			10.5	22.6	53
0.1 mM	O_2	9	shoot	*Lemna minor L.*	0.11	0.1	54
1 mM		-18			0.11	0.1	54
0.1 mM		8			0.13	0.1	54
1 mM		-23			0.13	0.1	54
0.1 mM		9			0.11	0.1	54
1 mM		-26			0.11	0.1	54
50 µm	H_2O_2	-8	Leaves	*Phaseolus aureus Roxb*	1.72	1.6	19
100 µm		-22			1.72	1.3	19
200 µm		-28			1.72	1.2	19
300 µm		-30			1.72	1.2	19
400 µm		-35			1.72	1.1	19
15 mg/L	H_2O_2	4	Leaves	*Cucumis sativus L.*	48	50.0	36
20 mg/L		5			48	50.4	
400 µM	H_2O_2	236	Shoot	*Solanum lycopersicum L.*	22	74	49
0.05 g/L	H_2O_2	-6	Seedlings	Canola	0.34	0.32	37
0.1 g/L		3			0.34	0.35	
0.25 g/L		35			0.34	0.46	
0.5 g/L		59			0.34	0.54	
1 g/L		106			0.34	0.7	
2 g/L		115			0.34	0.73	
4 g/L		147			0.34	0.84	
100 µM	H_2O_2	31	Leaves	*Brassica napus*	13	17	55
200 µM		85			13	24	
300 µM		192			13	38	
100 µM	H_2O_2	38	Roots	*Brassica napus*	8	11	55
200 µM		88			8	15	
300 µM		200			8	24	
100 µM	O_2	17	Leaves	*Brassica napus*	5.8	6.8	55

200 µM		64			5.8	9.5	
300 µM		124			5.8	13	
100 µM		15			3.4	3.9	55
200 µM	O_2	26	Roots	*Brassica napus*	3.4	4.3	
300 µM		88			3.4	6.4	
3 g/L	H_2O_2	3			58	60	
			Leaves	Peanut			23
3 g/L	H_2O_2	4			52	54	
50 mM	H_2O_2	31	Leaf	*Phaseolus vulgaris*	65	85	38

Table S9: Percent change in plant lipid peroxidation in response to Co.

Co dose	LPO	% change	Organ	Plant species	Control Values	Co-treated Value	Reference
300 µM	MDA	11	Leaf	Wheat	—	—	[50]
0 µM		0	Seed		0.35	0.35	
100 µM	MDA	17	Seed	*Ocimum basilicum L.*	0.35	0.41	[56]
500 µM		69	Seed		0.35	0.59	
150 µM	TBARS	76	shoot	*Triticum aestivum L.*	12.5	22	[51]
300 µM		132	shoot		12.5	29	
50 µM		5	Leaves		10.5	11	
100µM		14	Leaves		10.5	12	
150 µM	TBARS	19	Leaves	*Cicer arietinum L.*	10.5	12.5	[57]
200 µM		24	Leaves		10.5	13	
250 µM		38	Leaves		10.5	14.5	
200 µM	MDA	24	Shoot	*Lactuca sativa L*	12.58	15.66	[16]
50 µM	MDA	60	Shoot	barley	0.95	1.52	[12]
50 µM		52	root	barley	2.3	3.5	[12]
500 µM	TBARS	120	shoot	*Spinacia oleracea L.*	100	220	[33]
		-4	Shoot		54.2	52.2	
100 µM	MDA	126	Shoot	*Brassica junceaL.*	58.4	132.2	[45]
		177	Shoot		64.5	178.4	
50 µM		7			7	7.5	
150 µM	MDA	186	Shoot	*Triticum aestivum L.*	7	20	[29]
250 µM		300			7	28	
350 µM		436			7	37.5	
20 µM		-81	Shoot		0.607	0.116	
40 µM	TBARS	-88	Shoot	*Lippia filifolia*	0.607	0.07	[47]
60 µM		-88	Shoot		0.607	0.072	
50 µM		9			26.0	28.3	
100µM	TBARS	32	Seeds	*Cicer arietinum L.*	26.0	34.4	[32]
150 µM		55			26.0	40.3	
200 µM		85			26.0	48.1	
50 µM		11			32.8	36.3	
100µM	TBARS	33	Seeds	*Cicer arietinum L.*	32.8	43.6	[32]
150 µM		46			32.8	48.0	
200 µM		78			32.8	58.4	
500 µM	TBARS	5	shoot	*Salvia officinalis L.*	2.43	2.6	[52]
50 mg/kg	TBARS	-9	shoot	*Brassica Napus L.*	2.2	2.0	[53]
100 mg/kg		-9			2.2	2.0	

250 mg/kg		14			2.2	2.5	
500 mg/kg		118			2.2	4.8	
1000 mg/kg		214			2.2	6.9	
2000 mg/kg		214			2.2	6.9	
4000 mg/kg		291			2.2	8.6	
100 µM	MDA	20	Shoot	*Ocimum basilicum L.*	0.35	0.42	56
500 µM		71	Shoot		0.35	0.6	
0.1 mM	TBARS	17	shoot	*Lemna minor L.*	3	3.5	54
1 mM		50			3	4.5	
0.1 mM		-20			3.5	2.8	
1 mM		43			3.5	5.0	
0.1 mM		50			3	4.5	
1 mM		67			3	5.0	
20 µM	TBARS	-81	shoot	*Lippia filifolia*	0.607	0.116	47
40 µM		-88			0.607	0.07	
60 µM		-88			0.607	0.072	
100 mg/L	EL	-22	shoot	Daffodil	50	39	58
200 mg/L		-44			50	28	
300 mg/L		-8			50	46	
50 mg/L	EL	-6	shoot	*Brassica Napus* L.	17	16	53
100 mg/L		-3			17	16.5	
250 mg/L		24			17	21	
500 mg/L		106			17	35	
1000 mg/L		112			17	36	
2000 mg/L		206			17	52	
4000 mg/L		224			17	55	
50 µm	MDA	-2	Leaves	*Phaseolus aureus Roxb*	4.23	4.1	19
100 µm		-18			4.23	3.5	
200 µm		-29			4.23	3.0	
300 µm		-28			4.23	3.0	
400 µm		-28			4.23	3.0	
15 mg/L	MDA	-17	Leaves	*Cucumis sativus L.*	6	5.0	36
20 mg/L		8			6	6.5	
400 µM	MDA	-54	Shoot	*Solanum lycopersicum L.*	6	2.75	49
2.5 mg/L	MDA	20	Shoot	*Catharanthus roseus*	40	48	59
5 mg/L		57			35	55	
7.5 mg/L		51			43	65	
10 mg/L		63			46	75	
0.05 g/L	MDA	2	Seedlings	Canola	0.61	0.62	37
0.1 g/L		-3			0.61	0.59	

0.25 g/L		26			0.61	0.77	
0.5 g/L		31			0.61	0.8	
1 g/L		67			0.61	1.02	
2 g/L		95			0.61	1.19	
4 g/L		100			0.61	1.22	
100 µM		6			95	101	
200 µM	MDA	26	Roots	*Brassica napus*	95	120	[55]
300 µM		47			95	140	
100 µM		7			95	102	
200 µM	MDA	25	Leaves	*Brassica napus*	95	119	[55]
300 µM		37			95	130	
50 mM	MDA	267	Leaf	*Phaseolus vulgaris*	3	11	[38]
20 mg/kg	MDA	81	Leaf	Pakchois	155	280	[40]
40 mg/kg		119	Leaf		155	340	

Table S10: Percent variation in ascorbate peroxidase (APX) activity in response to Co

Co dose	Enzymes	% change	Organ	Plant species	Control Values	Co-treated Value	Reference
10 mg/L	APX	15	Roots	*Tagestes eracta*	38.1	44	27
20 mg/L		-8			38.1	35.1	
10 mg/L	APX	8	Leaves	*Tagestes eracta*	32.7	35.4	27
20 mg/L		-8			32.7	30	
150 µM	APX	-18	Shoot	*Triticum aestivum L*	5500	4500	51
300 µM		-36			5500	3500	
200 µM	APX	3750	Shoot	*Lactuca sativa L*	0.2	7.7	16
50 µM	APX	44	Shoot	*Triticum aestivum L.*	4.5	6.5	29
150 µM		89			4.5	8.5	
250 µM		167			4.5	12	
350 µM		44			4.5	6.5	
100 µM	APX	173	Shoot	*Ocimum basilicum L.*	1.5	4.1	56
500 µM		387			1.5	7.3	
400 µM	APX	-39	Shoot	*Solanum lycopersicum L.*	88	54	49
0.05 g/L	APX	3	Seedlings	Canola	1.61	1.66	37
0.1 g/L		4			1.61	1.68	
0.25 g/L		2			1.61	1.64	
0.5 g/L		24			1.61	2	
1 g/L		43			1.61	2.3	
2 g/L		61			1.61	2.6	
4 g/L		-7			1.61	1.5	
50 mM	APX	-41	Leaf	*Phaseolus vulgaris*	0.32	0.19	38

Table S11: Percent variation in CAT activity in response to Co

Co dose	Enzymes	% change	Organ	Plant species	Control Values	Co-treated Value	Reference
300 µM	CAT	28	Leaf	Wheat	—	—	[50]
10 mg/L	CAT	17	Roots	*Tagestes eracta*	29.3	34.4	[27]
20 mg/L		-9	Roots		29.3	26.6	
10 mg/L	CAT	13	Leaves	*Tagestes eracta*	23.9	27	[27]
20 mg/L		-12			23.9	21	
150 µM	CAT	56	Shoot	*Triticum aestivum L*	0.8	1.25	[51]
300 µM		63			0.8	1.3	
50 µM	CAT	-1	shoot	*Cicer arietinum L.*	150	148	[57]
100µM		-10			150	135	
150 µM		-17			150	125	
200 µM		-33			150	100	
250 µM		-40			150	90	
200 µM	CAT	800	shoot	*Lactuca sativa L*	0.25	2.25	[16]
50 µM	CAT	26	shoot	*Vigna radiata (L.)*	1	1.26	[41]
100µM		-10			1	0.9	
150 µM		-30			1	0.7	
200 µM		-33			1	0.67	
250 µM		-40			1	0.6	
100µM	CAT	3	Shoot	*Lycopersicon esculentum*	420	432	[60]
200 µM		10			420	460	
300 µM		13			420	475	
	CAT	-10	Shoot	*Brassica junceaL.*	42.5	38.2	[45]
100 µM		-29			48.4	34.5	
		-37			50.2	31.6	
50 µM	CAT	6	Shoot	*Triticum aestivum L.*	0.85	0.9	[29]
150 µM		-96			0.85	0.03	
250 µM		-98			0.85	0.02	
350 µM		-99			0.85	0.01	

50 µM		400			0.8	4.0	
100µM		-13			0.8	0.7	
150 µM	CAT	-31	Shoot	*Vigna radiata*	0.8	0.6	61
200 µM		-33			0.8	0.5	
250 µM		-38			0.8	0.5	
20 µM		-24			1.436	1.091	
40 µM	CAT	-94	Shoot	*Lippia filifolia*	1.436	0.092	47
60 µM		-98			1.436	0.035	
50 µM		-3			163.0	158	
100µM	CAT	423	Seeds	*Cicer arietinum L.*	26.0	136	32
150 µM		335			26.0	113	
200 µM		292			26.0	102	
50 µM		-2			195	192	
100µM	CAT	427	Seeds	*Cicer arietinum L.*	32.8	173	32
150 µM		345			32.8	146	
200 µM		281			32.8	125	
2 mM		39			1.55	2.15	
4 mM		85			1.55	2.86	
6 mM	CAT	136	shoot	*Eleusine coracana (L.)*	1.55	3.66	28
8 mM		141			1.55	3.73	
10 mM		172			1.55	4.22	
2 mM		39			1.55	2.15	
4 mM		85			1.55	2.86	
6 mM	CAT	136	shoot	*Eleusine coracana (L.)*	1.55	3.66	28
8 mM		141			1.55	3.73	
10 mM		172			1.55	4.22	
50 µM		50			0.7	1.05	
100µM		-9			0.7	0.64	
150 µM	CAT	-11	shoot	*Cyamopsis tetragonaloba*	0.7	0.62	62
200 µM		-13			0.7	0.61	
250 µM		-16			0.7	0.59	
20 µM		-24			1.436	1.091	
40 µM	CAT	0	shoot	*Lippia filifolia*	1.436	1.432	47
60 µM		-16			1.436	1.204	
400 µM	CAT	60	Shoot	*Solanum lycopersicum L.*	7.5	12	49
0.05 g/L		3			0.58	0.6	
0.1 g/L		2			0.58	0.59	
0.25 g/L		28			0.58	0.74	
0.5 g/L	CAT	29	Seedlings	Canola	0.58	0.75	37
1 g/L		-17			0.58	0.48	
2 g/L		-19			0.58	0.47	
4 g/L		-24			0.58	0.44	

3 g/L	CAT	-35	Leaves	Peanut	65	42	23
3 g/L		-27			55	40	
50 mM	CAT	63	Leaf	*Phaseolus vulgaris*	13.5	22	38
20 mg/kg	CAT	12	Leaf	Pakchois	580	650	40
40 mg/kg		22	Leaf		580	710	

Table S12: Percent variation in SOD activity in response to Co

Co dose	Enzymes	% change	Organ	Plant species	Control Values	Co-treated Value	Reference
300 µM	SOD	29	Leaf	Wheat	—	—	50
10 mg/L	SOD	17	Roots	*Tagestes eracta*	46.7	54.6	27
20 mg/L		-2	Roots		46.7	45.8	
10 mg/L	SOD	18	Leaves	*Tagestes eracta*	38.1	45.1	27
20 mg/L		-50			38.1	18.9	
150 µM	SOD	-20	Shoot	*Triticum aestivum L*	0.75	0.6	51
300 µM		-7			0.75	0.7	
50 µM	SOD	-1	shoot	*Cicer arietinum L.*	150	148	57
100µM		-7			150	140	
150 µM		-10			150	135	
200 µM		-20			150	120	
250 µM		-33			150	100	
100µM	SOD	14	Shoot	*Lycopersicon esculentum*	125	143	60
200 µM		21			125	151	
300 µM		30			125	163	
	SOD	9	Shoot	*Brassica junceaL.*	24.2	26.4	45
100 µM		56			28.4	44.2	
		156			32.2	82.4	
50 µM	SOD	11	Shoot	*Triticum aestivum L.*	1.8	2	29
150 µM		39			1.8	2.5	
250 µM		-17			1.8	1.49	
350 µM		-33			1.8	1.2	
20 µM	SOD	-47	Shoot	*Lippia filifolia*	0.499	0.266	47
40 µM		-19			0.499	0.403	
60 µM		-52			0.499	0.241	
50 µM	SOD	-8	Seeds	*Cicer arietinum L.*	138	127	32
100µM		-16			138	116	
150 µM		-24			138	105	
200 µM		-38			138	86	

50 µM	SOD	-8	Seeds	*Cicer arietinum L.*	165	152	32
100µM		-19			165	133	
150 µM		-27			165	121	
200 µM		-36			165	105	
20 µM	SOD	-47	shoot	*Lippia filifolia*	0.499	0.266	47
40 µM		-19			0.499	0.402	
60 µM		-52			0.499	0.241	
15 mg/L	SOD	0	Leaves	*Cucumis sativus L.*	0.6	0.6	36
20 mg/L		-10			0.6	0.5	
400 µM	SOD	-71	Shoot	*Solanum lycopersicum L.*	1.4	0.41	49
0.05 g/L	SOD	-2	Seedlings	Canola	1.23	1.21	37
0.1 g/L		2			1.23	1.25	
0.25 g/L		24			1.23	1.52	
0.5 g/L		24			1.23	1.53	
1 g/L		46			1.23	1.8	
2 g/L		52			1.23	1.87	
4 g/L		-4			1.23	1.18	
50 mM	SOD	100	Leaf	*Phaseolus vulgaris*	44	88	38
20 mg/kg	SOD	8	Leaf	Pakchois	79	85	40
40 mg/kg		20	Leaf		79	95	

Table S13: Percent variation in GR activity in response to Co

Co dose	Enzymes	% change	Organ	Plant species	Control Values	Co-treated Value	Reference
10 mg/L	GR	16	Roots	*Tagestes eracta*	39.1	45.5	[27]
20 mg/L		-25	Roots		39.1	29.4	
10 mg/L	GR	21	Shoot	*Tagestes eracta*	22.3	26.9	[27]
20 mg/L		-9			22.3	20.2	
150 µM	GR	-22	Shoot	*Triticum aestivum L*	205	160	[51]
300 µM		2			205	210	
50 µM	GR	6	shoot	*Cicer arietinum L.*	1.6	1.7	[57]
100µM		-13			1.6	1.4	
150 µM		-25			1.6	1.2	
200 µM		-44			1.6	0.9	
250 µM		-75			1.6	0.4	
50 µM	GR	220	Shoot	barley	1	3.2	[12]
50 µM		300	root		1	4	
100 µM	GR	55	Shoot	*Brassica juncea L.*	32.4	50.2	[45]
		82			41.2	74.8	
		99			59.4	118.2	
50 mM	GR	-45	Leaf	*Phaseolus vulgaris*	11	6	[38]

Table S14: Percent variation in POD activity in response to Co

Co dose	Enzymes	% change	Organ	Plant species	Control Values	Co-treated Value	Reference
300 µM	POD	25	Leaf	Wheat	—	—	[50]
10 mg/L	POD	9	Roots	*Tagestes eracta*	48.2	52.7	[27]
20 mg/L		-11	Roots		48.2	42.8	
10 mg/L	POD	4	Leaves	*Tagestes eracta*	44.2	46.1	[27]
20 mg/L		-12			44.2	38.8	
50 µM	POD	6	shoot	*Cicer arietinum L.*	16	17	[57]
100µM		-13			16	14	
150 µM		-38			16	10	
200 µM		-50			16	8	
250 µM		-59			16	6.5	
50 µM	POD	-17	shoot	*Vigna radiata (L.)*	0.3	0.25	[41]
100µM		17			0.3	0.35	
150 µM		27			0.3	0.38	
200 µM		29			0.3	0.386	
250 µM		30			0.3	0.39	
100µM	POD	27	shoot	*Salix babylonica*	4.9	6.2	[44]
		69	Root	*Salix babylonica*	2.9	4.9	[44]
100µM	POD	4	Shoot	*Lycopersicon esculentum*	13.3	13.8	[60]
200 µM		8			13.3	14.3	
300 µM		7			13.3	14.2	
50 µM	POD	5	Shoot	*Vigna radiata*	0.2	0.2	[61]
100µM		25			0.2	0.3	
150 µM		50			0.2	0.3	
200 µM		60			0.2	0.3	
250 µM		100			0.2	0.4	
20 µM	POD	-48	Shoot	*Lippia filifolia*	0.157	0.082	[47]
40 µM		4			0.157	0.163	
60 µM		-18			0.157	0.128	

50 µM	POD	-8	Seeds	*Cicer arietinum L.*	17.3	15.9	32
100µM		-20			17.3	13.8	
150 µM		-27			17.3	12.6	
200 µM		-41			17.3	10.2	
50 µM	POD	-6	Seeds	*Cicer arietinum L.*	21.7	20.5	32
100µM		-25			21.7	16.2	
150 µM		-33			21.7	14.5	
200 µM		-45			21.7	12	
2 mM	POD	2	shoot	*Eleusine coracana (L.)*	6.88	7	28
4 mM		5			6.88	7.19	
6 mM		15			6.88	7.9	
8 mM		26			6.88	8.68	
10 mM		45			6.88	10.01	
20 µM	POD	-48	shoot	*Lippia filifolia*	0.157	0.082	47
40 µM		4			0.157	0.163	
60 µM		-18			0.157	0.128	
15 mg/L	POD	0	Leaves	*Cucumis sativus L.*	40.2	40.0	36
20 mg/L		0			40.1	40.0	
400 µM	POD	217	Shoot	*Solanum lycopersicum L.*	1.2	3.8	49
0.05 g/L	POD	4	Seedlings	Canola	1.02	1.06	37
0.1 g/L		2			1.02	1.04	
0.25 g/L		36			1.02	1.39	
0.5 g/L		41			1.02	1.44	
1 g/L		-2			1.02	1	
2 g/L		-15			1.02	0.87	
4 g/L		-23			1.02	0.79	
3 g/L	POD	100	Leaves	Peanut	30	60	23
3 g/L		71			38	65	
50 mM	POD	-63	Leaf	*Phaseolus vulgaris*	19	7	38

Table S15: Percent variation in plant non-enzymes activity in response to Co

Co dose	Non-enzymes	% change	Organ	Plant species	Control Values	Co-treated Value	Reference
300 µM	Proline	24	Leaf	Wheat	—	—	[50]
10 mg/L	GSH	8	Roots	*Tagestes eracta*	143.9	156	[27]
20 mg/L		-2			143.9	141	
10 mg/L	GSSG	21	Roots	*Tagestes eracta*	65.1	78.7	[27]
20 mg/L		-3			65.1	63.3	
10 mg/L	AsA	29	Roots	*Tagestes eracta*	45.2	58.5	[27]
20 mg/L		-7			45.2	42.1	
10 mg/L	GST	14	Roots	*Tagestes eracta*	32.4	36.9	[27]
20 mg/L		-42			32.4	18.8	
10 mg/L	DHAR	17	Roots	*Tagestes eracta*	22.9	26.8	[27]
20 mg/L		-7			22.9	21.2	
10 mg/L	MDHAR	18	Roots	*Tagestes eracta*	45.2	53.2	[27]
20 mg/L		-8			45.2	41.7	

10 mg/L	DHA	22	Roots	*Tagestes eracta*	54.5	66.3	27
20 mg/L		-6			54.5	51	
10 mg/L	Gly I	117	Roots	*Tagestes eracta*	0.6	1.3	27
20 mg/L		-67			0.6	0.2	
50 µM		15			6.5	7.5	
100µM		54			6.5	10	
150 µM	Proline	92	Leaves	*Cicer arietinum L.*	6.5	12.5	57
200 µM		115			6.5	14	
250 µM		138			6.5	15.5	
200 µM	Proline	283	Shoot	*Lactuca sativa L*	0.12	0.46	16
50 µM	PC	450	Shoot	*Hordeum vulgare*	2	11	12
		1900	root		1	20	
	GSH	127	Shoot		0.55	1.25	
		145	root		2	4.9	
	GSSH	160	Shoot		0.15	0.39	
		198	root		0.4	1.19	
100µM	GSH	19	Shoot	*Salix babylonica*	0.16	0.19	44
		-33	root		0.03	0.02	
100µM	Proline	20	Shoot	*Lycopersicon esculentum*	9.61	11.5	60
200 µM		66			9.61	16	
300 µM		98			9.61	19	
100 µM	Proline	16	Shoot	*Brassica junceaL.*	1.84	2.14	45
		83			2.01	3.68	
		170			2.21	5.96	
100 µM	DHAR	103	Shoot	*Brassica junceaL.*	42.4	86.2	45
		138			52.1	124.1	
		176			66.2	182.8	
100 µM	GSH	18	Shoot	*Brassica junceaL.*	103.5	122.6	45
		82			92.4	168.2	
		145			74.5	182.4	
100 µM	GSSG	7	Shoot	*Brassica junceaL.*	39.6	42.2	45
		129			34.5	78.9	
		170			31.2	84.2	
100 µM	DHA	19	Shoot	*Brassica junceaL.*	3.39	4.02	45

		69			4.01	6.79	
		91			6.01	11.49	
150 µM	GSH	-13	Leaves	*Triticum aestivum L.*	1950	1700	51
300 µM		-23			1950	1500	
150 µM	GSSH	12	Leaves	*Triticum aestivum L.*	58	65	51
300 µM		9			58	63	
150 µM	DHA	44	Leaves	*Triticum aestivum L.*	35	50.5	51
300 µM		89			35	66	
50 µM	Amino acid	10	Shoot	*Vigna radiata*	2.8	3.1	61
100µM		-6			2.8	2.7	
150 µM		-13			2.8	2.5	
200 µM		-25			2.8	2.1	
250 µM		-32			2.8	1.9	
50 µM	Proline	17	Seeds	*Cicer arietinum L.*	9.4	11.0	32
100µM		29			9.4	12.1	
150 µM		54			9.4	14.5	
200 µM		69			9.4	15.9	
50 µM	Proline	9	Seeds	*Cicer arietinum L.*	11.81	12.9	32
100µM		11			11.81	13.2	
150 µM		42			11.81	16.8	
200 µM		60			11.81	18.9	
2 mM	Amino acid	13	Shoot	*Eleusine coracana (L.)*	16.36	18.41	28
4 mM		26			16.36	20.65	
6 mM		60			16.36	26.25	
8 mM		124			16.36	36.61	
10 mM		203			16.36	49.61	
2 mM	Proline	24	Shoot	*Eleusine coracana (L.)*	2.91	3.62	28
4 mM		48			2.91	4.3	
6 mM		77			2.91	5.14	
8 mM		93			2.91	5.61	
10 mM		99			2.91	5.78	
0 µM	Proline	1	Shoot	*Lycopersicon esculentum*	6.82	6.87	Hasan et al., 2011
100µM		18			6.82	8.08	
200 µM		40			6.82	9.56	
300 µM		61			6.82	10.97	
0.05 g/L	Other aldehydes	2	Seedlings	Canola	1.1	1.12	37
0.1 g/L		-1			1.1	1.09	
0.25 g/L		6			1.1	1.17	
0.5 g/L		33			1.1	1.46	
1 g/L		35			1.1	1.49	
2 g/L		52			1.1	1.67	
4 g/L		54			1.1	1.69	
0.05 g/L	LOX	-5	Seedlings	Canola	0.019	0.018	37

0.1 g/L		0			0.019	0.019	
0.25 g/L		26			0.019	0.024	
0.5 g/L		37			0.019	0.026	
1 g/L		74			0.019	0.033	
2 g/L		89			0.019	0.036	
4 g/L		132			0.019	0.044	
0.05 g/L		-90			0.98	0.097	
0.1 g/L		-90			0.98	0.098	
0.25 g/L		18			0.98	1.16	
0.5 g/L	Proline	20	Seedlings	Canola	0.98	1.18	37
1 g/L		36			0.98	1.33	
2 g/L		47			0.98	1.44	
4 g/L		-91			0.98	0.085	
0.05 g/L		2			71.39	73	
0.1 g/L		2			71.39	73	
0.25 g/L		1			71.39	72	
0.5 g/L	DPPH	18	Seedlings	Canola	71.39	84	37
1 g/L		20			71.39	86	
2 g/L		-5			71.39	68	
4 g/L		-9			71.39	65	
0.05 g/L		3			1.53	1.57	
0.1 g/L		5			1.53	1.6	
0.25 g/L		2			1.53	1.56	
0.5 g/L	Phenol	22	Seedlings	Canola	1.53	1.86	37
1 g/L		29			1.53	1.98	
2 g/L		-10			1.53	1.38	
4 g/L		-15			1.53	1.3	
0.05 g/L		-1			1.36	1.34	
0.1 g/L		0			1.36	1.36	
0.25 g/L		13			1.36	1.54	
0.5 g/L	Protein contents	24	Seedlings	Canola	1.36	1.68	37
1 g/L		-5			1.36	1.29	
2 g/L		-15			1.36	1.15	
4 g/L		-26			1.36	1	
3 g/L	Proline	-13	Leaves	Peanut	200	175	23
3 g/L		4			125	130	
3 g/L	Phenolics	5	Leaves	Peanut	38	40	23
3 g/L		3			35	36	
50 mM	Soluble proteins	-27	Leaf	*Phaseolus vulgaris*	15	11	38
50 mM	Free amino	-13			2.4	2.1	

	acids						
50 mM	Free proline	25			22	27.5	
50 mM	Phenolics	15	Leaf	*Phaseolus vulgaris*	4.8	5.5	[38]
50 mM	Flavonoids	-31			2.6	1.8	

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