Numerical Data

Effect of copper on nutrients content (mg g–1 dry wt.) of radish (45th day)

Copper added in the soil (mg kg^{-1})	N	P	K	Na	Ca	Mg
Control	32.66	6.31	43.52	1.70	13.56	3.99
50	37.35(+14.36)	6.97(+10.45)	52.09(+19.69)	2.11 (+24.11)	15.98 (+17.84)	4.91 (+23.05)
100	25.28 (22.59)	5.71 (-9.50)	36.78 (-15.48)	1.39 (-18.23)	12.25 (-9.66)	3.48 (-12.78)
150	23.73 (27.34)	5.06 (-19.80)	32.17 (-26.07)	1.28 (-24.70)	11.14 (-17.84)	3.05 (-23.55)
200	20.98 (35.76)	4.81 (-23.77)	30.37 (-30.21)	1.16 (-31.76)	11.30 (-19.05)	2.75 (-31.07)
250	18.07 (44.67)	3.90 (-38.19)	25.11 (-42.30)	1.10 (-35.29)	10.68 (-21.23)	2.11 (-47.11)

Average of five replications
Per cent over control values are given in parentheses(2017)

NPs [mg L-1]	Germination [%]	Shoot length [mm]	Root length [mm]	Shoot biomass [g]		Root biomass [g]	
				FM	DM	FM	DM
0	96.0 ± 3.97a	35.2 ± 6.36ab	48.4 ± 6.33a	0.64 ± 0.01a	0.087 ± 0.05c	0.192 ± 0.02c	0.025 ± 0.01a
2.5	94.7 ± 3.10ab	31.0 ± 1.22bc	45.8 ± 5.96a	0.64 ± 0.02a	0.092 ± 0.03a	0.193 ± 0.03c	0.021 ± 0.02e
10	90.1 ± 1.86bc	27.8 ± 1.64cd	43.8 ± 6.89ab	0.63 ± 0.02a	0.087 ± 0.02b	0.205 ± 0.02b	0.021 ± 0.01e
50	89.7 ± 6.61c	39.0 ± 3.36a	48.5 ± 2.88a	0.61 ± 0.02a	0.078 ± 0.01d	0.188 ± 0.02d	0.023 ± 0.01c
100	89.2 ± 4.53c	25.7 ± 3.36d	42.2 ± 3.53ab	0.43 ± 0.01b	0.071 ± 0.03f	0.180 ± 0.02e	0.024 ± 0.01b
1000	88.7 ± 4.82c	24.3 ± 3.12d	37.2 ± 4.35b	0.44 ± 0.05b	0.075 ± 0.02e	0.209 ± 0.01a	0.021 ± 0.01d

Percentage of germination, shoot, root length, and biomass (fresh mass – FM, and dry mass – DM) of Oryza sativa treated with CuO nanoparticles (NPs) at different concentrations. Mean values ± SD (n = 5). Means in the column followed by the same letter do not differ significantly at $p \leq 0.05$.(2016)

Source: https://link.springer.com/content/pdf/10.1007%2Fs11099-015-0167-5.pdf

Changes in the plant height, root length, total dry weight, and leaf area of the lentil plants subjected to different treatments of copper stress and P. vermicola inoculation

	Plant height (cm)	Root length (cm)	Total dry weight	
T0	34.67±4.5[a]	14.76±1.3[b]	11.87±0.75[ab]	110.00±3.79[b]
T1	22.78±3.8[c]	7.34±0.50[d]	7.20±1.0[c]	77.00±3.19[c]
T2	37.30±5.9[a]	16.80±1.15[a]	12.40±1.4[a]	136.00±5.03[a]
T3	29.90±2.1[b]	11.21±1.06[c]	9.90±1.2[b]	101.00±4.73[b]

Values are means±S.E. (n=3). Values carrying different letters are significantly different at P≤ 0.05 level As
determined by Duncan'stestT0 non-contaminated soil, T1 Cu amended soil, T2 non-contaminated soil+P. vermicolainoculation,T3 Cuamended soil+P. vermicolainoculation

Source: Environ Sci Pollut Res (2016) 23:220–233

P. vermicola inoculation and copper induced changes in different photosynthetic attributes of lentil plants

Treatments	Gs (mol m^{-2} s^{-1})	Ci (ì mol mol^{-1})	E(mmol H2O $m^{-2}s^{-1}$)	A(ì mol CO2 $m^{-2}s^{-1}$)	A/E (ì mol CO2 /mmol H2O)
T0	0.049±0.003[b]	281±5.568[b]	0.512±0.012[b]	10.36±0.606[b]	0.291±0.011[b]
T1	0.023±0.001[d]	190±5.686[d]	0.255±0.104[d]	4.48±0.211[d]	0.103±0.003[d]
T2	0.079±0.002[a]	327±8.686[a]	0.595±0.014[a]	13.33±0.620[a]	0.331±0.007[a]
T3	0.037±0.00[c]	236±8.386[c]	0.423±0.012[c]	7.83±0.500[c]	0.243±0.006[c]

Values are means±S.E. (n=3). Values carrying different letters are significantly different atP≤0.05 level as determined by Duncan's testT0non-contaminated soil,T1Cu amended soil,T2non-contaminated soil+P. vermicolainoculation,T3Cu amended soil+P. vermicolainoculation

Source: springer.com/static/pdf/568/art%253A10.1007%252Fs11356-015-5354-1.pdf

Effect of Cu and castasterone on ROS indicators (superoxide anion and hydrogen peroxide content), photosynthetic pigments (chlorophyll a, b, total carotenoids content) and anthocyanin content in 60 days old B. juncea plants

Treatments		Superoxide anion radical content (µg g^{-1} FW	Hydrogen peroxide content (µmol g^{-1} FW)	Chlorophyll a content (mg g^{-1} FW)	Chlorophyll b content(mg g^{-1} FW)	Total chlorophyll content(mg g^{-1} FW)	Carotenoids content (mg g^{-1} FW)	Anthocyanin content (µg g^{-1} FW)
Cu (mM)	CS (M)							
0	0	6.74 ± 0.31	1.23 ± 0.03	1.76 ± 0.06	0.64 ± 0.04	2.38 ± 0.04	0.047 ± 0.001	5.25 ± 0.06
0.25	0	7.84 ± 0.81	1.36 ± 0.05	1.49 ± 0.05	0.55 ± 0.02	2.02 ± 0.06	0.070 ± 0.010	5.82 ± 0.01
0.50	0	8.03 ± 0.43	1.81 ± 0.05	1.38 ± 0.08	0.52 ± 0.07	1.89 ± 0.07	0.068 ± 0.004	6.50 ± 0.98
0.75	0	9.87 ± 0.19	2.07 ± 0.6	1.33 ± 0.06	0.51 ± 0.06	1.83 ± 0.04	0.064 ± 0.005	6.09 ± 0.06
0	10^{-11}	6.63 ± 0.41	1.10 ± 0.03	1.75 ± 0.09	0.57 ± 0.01	2.31 ± 0.08	0.084 ± 0.006	5.47 ± 0.07
0	10^{-9}	6.60 ± 0.27	1.18 ± 0.06	1.60 ± 0.15	0.68 ± 0.01	2.26 ± 0.01	0.071 ± 0.003	5.43 ± 0.06
0	10^{-7}	6.84 ± 0.16	1.15 ± 0.02	1.72 ± 0.09	0.63 ± 0.08	2.33 ± 0.08	0.072 ± 0.006	6.13 ± 1.04
0.25	10^{-11}	7.15 ± 0.48	1.30 ± 0.11	1.59 ± 0.07	0.57 ± 0.10	2.15 ± 0.07	0.070 ± 0.012	7.55 ± 0.10
0.25	10^{-9}	7.13 ± 0.15	1.21 ± 0.10	1.64 ± 0.05	0.60 ± 0.03	2.22 ± 0.08	0.075 ± 0.001	7.63 ± 0.08
0.25	10^{-7}	6.95 ± 0.29	1.22 ± 0.02	1.63 ± 0.03	0.62 ± 0.08	2.23 ± 0.05	0.072 ± 0.002	7.78 ± 0.08
0.50	10^{-11}	7.63 ± 0.56	1.80 ± 0.07	1.51 ± 0.04	0.55 ± 0.01	2.05 ± 0.03	0.071 ± 0.002	9.54 ± 0.09
0.50	10^{-9}	7.89 ± 0.48	1.65 ± 0.07	1.50 ± 0.06	0.55 ± 0.02	2.03 ± 0.05	0.075 ± 0.007	9.16 ± 0.98
0.50	10^{-7}	7.71 ± 0.90	1.75 ± 0.06	1.64 ± 0.01	0.60 ± 0.05	2.22 ± 0.04	0.077 ± 0.010	9.14 ± 0.99
0.75	10^{-11}	7.65 ± 0.05	1.83 ± 0.08	1.43 ± 0.05	0.51 ± 0.06	1.93 ± 0.09	0.066 ± 0.007	11.53 ± 0.09
0.75	10^{-9}	9.24 ± 0.13	1.82 ± 0.05	1.41 ± 0.05	0.52 ± 0.04	1.92 ± 0.08	0.068 ± 0.003	11.59 ± 0.06
0.75	10^{-7}	8.47 ± 0.22	1.89 ± 0.07	1.42 ± 0.03	0.53 ± 0.04	1.93 ± 0.06	0.070 ± 0.001	11.68 ± 0.07
F-ratio (Cu) df 3,32		51.43**	399.42**	42.74**	6.01**	97.89**	8.24**	186.64**
F-ratio (CS) df 3,32		8.55**	13.21**	5.75**	1.34	12.07**	0.073	83.19**
F-ratio (Cu × CS) df 9,32		3.16**	2.42*	2.95*	0.49	4.76**	3.24*	14.14**
HSD (p < 0.05)		1.310	0.192	0.209	0.200	0.192	0.019	1.521

Note: Data represent the mean ± SD of three replicates.
*p < 0.05.
**p < 0.01.
Source: http://www.tandfonline.com/doi/pdf/10.1080/23311932.2016.1276821?needAccess=true

Effect of Cu and castasterone on contents of various polyphenols (ìg g-1) in 60 days old B. juncea plants

Polyphenol detected	Control	10^{-7} M CS	0.50 mM Cu	0.50 mM Cu +10^{-7} M CS
Catechin	nd	nd	32.348	161.128
Chlorogenic acid	96.824	108.236	91.516	63.064
Epicatechin	nd	nd	32.94	48.188
Caffeic acid	509.832	443.156	482.524	416.696
Coumaric acid	0.6	0.3	5.14	0.824
Rutin	37.9	31.548	44.676	55.04
Quercetin	2.524	0.832	nd	nd
Umbelliferone	nd	1.544	47.752	7.436
Ellagic acid	61.248	87.732	41.288	338.328
Kaempferol	nd	22.832	28.584	42.592
Tert-butyl hydroquinone	nd	nd	1.332	nd
Total content	708.928	696.18	808.1	1,133.296

Note: nd—not detected.

Source: Poonam at al.(2016), Castasterone assisted accumulation of polyphenols and antioxidant to increase tolerance of B. juncea plants towards copper toxicity, Cogent Food & Agriculture

Relationship between copper concentration in growth medium and its uptake in crops. Copper was mainly accumulated in roots and less translocated to shoots. Cu in plant parts did not linearly increase with increasing Cu levels in the growth medium

Exp.	Cu concentration in medium	Duration (days)	Crop type	Uptake and accumulation (mg kg^{-1})	References
Hydroponics	50 to 150 μM	10	Rapeseed	Leaves 107.9–203.1	Ivanova et al. 2010
				Root 297.3–383.7	
	0.1 to 10 mM	6	Maize	Root 5.9–1668.2	Benimali et al. 2010
	10 to 50 μM	14	Rapeseed	Root 740.40–2478	Feigl et al. 2013
				Shoot 57.6–82.01	
				Shoot 5.83–594.8	
				Leaves 13.5–160.9	
	10 to 50 μM	14	Indian mustard	Root 686.1–3637	Feigl et al. 2013
				Shoot 49.7–88.2	
	4 to 80 μM	15	Maize	Root 299–7790	Ouzounidou et al. 1995
	75 μM	7	Wheat	Root 618.5	Gajewska and Sklodowska
				Shoot 21.5	2010
	10^{-3} M	6	Maize	Root 1070	Lin et al. 2003
				Shoot 56	
	1.6 to 192 μM	35	Soybean	Leaves 67	Sanchez-Pardo et al. 2014
Sand	20 mg kg^{-1}	20	Cucumber	Root 299	Alaoui-Sossé et al. 2004
Soil	1338 mg kg^{-1}	50	Green gram	Root 60	Wani et al. 2007
				Shoot 26.2	
	50 to 250 mg kg^{-1}	45	Green gram	Shoot 46.6–150	Manivasagaperumal et al. 2011

Environ Sci Pollut Res (2015)

Source:https://www.researchgate.net/profile/Muhammad_Rizwan16/publication/274963313_The_effect_of_excess_copper_on_growth_and_physiology_of_important_food_crops_a_review/links/5711f8c308aeff315ba038e1/The-effect-of-excess-copper-on-growth-and-physiology-of-important-food-crops-a-review.pdf