

Table 1: Positive or no consequential effects of nanoparticles in food crops

Nanoparticle	Particle size (nm)	Plant	Concentration (mg L ⁻¹)	Observed toxicity	Reference
Zero valent Fe	-	Flax, Red clover, White clover, Meadow fescue	100, 250, 500	No effect on germination	El-Temsah and Joner, 2010
		Barley, Ryegrass	100, 250	No effect on germination	El-Temsah and Joner, 2010
Al		Radish, Rape, Lettuce, Corn, Cucumber	2000	No effect on germination	Lin and Xing, 2007
	1–100	Red kidney beans, Ryegrass	10, 100, 1000, 10000	No observed toxicity	Doshi et al, 2008
	-	Radish, Rape	2000	Improved root growth	Lin and Xing, 2007
Ag	20	Flax	20, 40, 60, 80, 100	No effect on the germination	El-Temsah and Joner, 2010
	2	Cucumber, Lettuce	62, 100, 116	Low to zero toxicity	Barrena et al, 2009
Au	10	Cucumber, Lettuce	62, 100, 116	Positive effect on germination index	Barrena et al, 2009
Si	-	Zucchini	1000	No effect on the germination	Stampoulis et al, 2009
Cu	-	Lettuce	0.013% (w/w)	No effect on the germination; improved shoot/root ratio	Shah and Belozerova, 2009
Dodecanethiol functionalized Au	-	Lettuce	0.013% (w/w)	No effect on the germination; improved shoot/root ratio	Shah and Belozerova, 2009
Pd entrapped in Al(OH) ₂ matrix	-	Lettuce	0.013–0.066% (w/w)	No effect on the germination; improved	Shah and Belozerova, 2009

				shoot/root ratio	
3-amino functionalized SiO ₂	-	Lettuce	0.013–0.066% (w/w)	No effect on the germination; improved shoot/root ratio	Shah and Belozeroval, 2009
CeO ₂	7	Corn, Alfalfa, Soybean	500, 1000, 2000, 4000	Significantly increased root and stem growth	Doshi et al, 2008
	<25	Wheat	100		Wild and Jones, 2009
ZnO	8	Soybean	500	Increased root growth	Lopez-Moreno et al, 2002
Al ₂ O ₃		Radish, Rape, Ryegrass, Lettuce, Corn, Cucumber	2000	No effect on germination	Lin and Xing, 2007
Fe ₃ O ₄	20	Pumkin	500	No toxic effect	Lopez-Moreno et al, 2010
	7	Cucumber, Lettuce	62, 100, 116	Low to zero toxicity	Barrena et al, 2009
TiO ₂	<100	Wheat	100		Wild and Jones, 2009
Nanoanatase (TiO ₂)	4–6	Spinach	0.25%	Enhanced rca mRNA expressions (51%), protein levels (42%), activity of Rubisco activase, Rubisco carboxylation, the rate of photosynthetic carbon reaction, single plant dry weight, chlorophyll content	Gao et al, 2006
	5	Spinach	0.25%	Improved spinach growth	Yang et al,

				related to N ₂ fixation by TiO ₂	2007
	5	Spinach	0.25%	Improved light absorbance, transformation from light energy to electron energy, and active chemical energy, and promoted carbon dioxide assimilation	Linglan et al, 2008
Rutile (TiO ₂)	-	Spinach (naturally aged)	0.25–4%	Increased germination and vigor indexes, plant dry weight, chlorophyll formation, ribulosebisphosphate carboxylase/oxygenase activity, photosynthetic rate	Zheng et al, 2005
	-	Spinach	0.25–4%	Promoted photosynthesis, the rate of evolution of oxygen in the chloroplasts was accelerated	Hong et al, 2005

Ni(OH) ₂	8.7	Mesquite	2	No effect	Parsons et al,2010
Mixture of SiO ₂ /TiO ₂		Soybean		Increased germination and shoot growth Increased nitrate reductase activity Increased absorption and utilization of water/fertilizer Enhanced antioxidant system	Lu et al, 2002
Mixture of Au/Cu	-	Lettuce	0.013% (w/w)	No effect on the germination; improved shoot/root ratio	Shah and Belozeroval, 2009
Multi-walled carbon nanotube	-	Tomato	10–40	Significant increase in germination rate, fresh biomass, and length of stem; significantly enhanced moisture content inside tomato seeds	Khodakovskaya et al,2009
	-	Radish, Rape, Ryegrass, Lettuce, Corn,	2000	No effect on germination	Lin and Xing, 2007

		Cucumber			
	-	Ryegrass	2000	Increased root length	Lin and Xing, 2007
	-	Zucchini		No effect on the germination	Stampoulis et al, 2009
	internal dimension: 110–170	Wheat	100	No significant effect on root or shoot growth	Wild and Jones, 2009
Single-walled carbon nanotube	8	Onion, Cucumber	104, 315, 1750	Significantly increased root length	Canas et al, 2008
	8	Cabbage, Carrot, Lettuce	104, 315, 1750	No effect	Canas et al, 2008
Functionalized single-walled carbon nanotube	8	Cabbage, Carrot, Tomato, Onion, Lettuce	9, 56, 315, 1750	No effect	Canas et al, 2008

Source: (Cyren et al, 2011)

Table 2: Semi quantitative SEM-EDS analysis of contaminated and nanometallic Ca/Cao treated soil^a

Element	Heavy metal contaminated soil		Nano- Ca/Cao treated soil		
	Mass%	Atom%	Mass%	Atom%	Mass percentage removal (%)
Si	89.1	96.6	37.0	45.7	58

Ca	1.4	1.04		62.6	54.1	-98 ^b
Cr	0.3	0.15		0.2	0.1	40
As	0.1	0.10		0.0	0.0	100
Cd	6.6	1.68		0.0	0.0	100
Pb	2.6	0.39		0.3	0.04	90
Total	100	100		100	100	-

^a Data represent an average of triplicates

^b Minus value denotes an increase in soil

Source: Srinivasa et al, 2012