

Table 1 Suppl. A selection of minerals with rare earth elements (REE) including rare-earth oxides (REO). Minerals in **bold** indicates a great importance for industrial production. Symbol ? signifies uncertainty of presented formula or crystal system. Modified from Clar 1984 ⁽¹⁾, Walters and Lusty 2010 ⁽²⁾.

Minerals	Formulas ^{1,2}	Crystal systems ¹	Mass of REE in REO [%] ²
Aeschynite	(Ce,Ca,Fe, Th)(Ti,Nb) ₂ (O,OH) ₆	orthorhombic (metamict)	32
Allanite	(Ce,Ca,Y) ₂ (Al,Fe ³⁺) ₃ (SiO ₄) ₃ OH	monoclinic	38
Apaptite	Ca ₅ (PO ₄) ₃ (F,Cl,OH)	hexagonal	19
Bastnäsité	(Ce,La)(CO ₃)F	hexagonal	75
Britholite	(Ce,Ca) ₅ (SiO ₄ PO ₄) ₃ (OH,F)	hexagonal	32
Cerite	(Ce,Ca),(Mg,Fe ²⁺)Si ?(O,OH,F) ₂₈	trigonal	-
Eudialyte	Na ₄ (Ca,Ce) ₂ (Fe ²⁺ Mn, Y)ZrSi ₈ O ₂₂ (OH,Cl) ₂ (?)	trigonal	9
Euxenite	(Y,Ca,Ce,U,Th)(Nb,Ta,Ti) ₂ O ₆	orthorhombic	24
Fergusonite	(Ce,La,Nd)NbO ₄	tetragonal (metamict)	53
Fluocerite	(Ce, La)F ₃	hexagonal	-
Gadolinite	(Ce,La,Nd,Y)2Fe ²⁺ Be2Si ₂ O ₁₀	monoclinic	60
Loparít	(Ce,La,Na,Ca,Sr)(Ti,Nb)O ₃	orthorhombic ?	30
Monazite	(Ce, La, Nd, Th) PO ₄	monoclinic	65
Parisit	Ca(Ce,La) ₂ (CO ₃) ₃ F ₂	hexagonal	61
Stillwellite	(Ce,La,Ca)BSiO ₃	trigonal	-
Synchisite	Ca(Ce,La)(CO ₃) ₂ F	hexagonal	51
Xenotime	YPO ₄	tetragonal	61
Ytrocercite	(Ca,Ce,Y,La)F ₃ nH ₂ O	cubic	53

Table 2 Suppl. Average abundance of rare earth elements (REE) [mg kg⁻¹]. Modified from Rudnick and Gao 2003⁽¹⁾ and Taylor *et al.* 1981⁽²⁾.

Element	Lower crust ¹	Middle crust ¹	Upper crust ¹	Upper crust ²
Lanthanum	8.0	24.0	31.0	30.0
Cerium	20.0	53.0	63.0	64.0
Praseodymium	2.4	5.8	7.1	7.1
Neodymium	11.0	25.0	27.0	26.0
Promethium	-	-	-	-
Samarium	2.8	4.6	4.7	4.5
Europium	1.1	1.4	1.0	0.88
Gadolinium	3.1	4.0	4.0	3.8
Terbium	0.48	0.7	0.7	0.64
Dysprosium	3.1	3.8	3.9	3.5
Holmium	0.68	0.82	0.83	0.8
Erbium	1.9	2.3	2.3	2.3
Thulium	0.24	0.32	0.3	0.33
Ytterbium	1.5	2.2	2.0	2.2
Lutetium	0.25	0.4	0.31	0.29
Yttrium	16.0	20.0	21.0	22.0
Scandium	31.0	19.0	14.0	10.0
Total LREE	45.30	113.8	133.8	132.48
Total HREE + Y	27.25	34.54	35.34	35.86
Ratio of LREE/HREE	4.03	7.83	3.79	3.69

Table 3 Suppl. Effects of REEs on yield and quality of selected crops.

Plant species	Increase in yield [%]	Element	Effect on quality	References
Cereal crops				
Corn	7 - 14			Xiong 1995
	6 - 12	REE	increased mass of 100 grain by 0.2 - 0.35 g	Xiong 1995, Guo 1993
	8.5 - 103	REE	–	
		REE nitrate	increase of leaf area index by 15.4 %	Cui and Zhao 1994
		REE nitrate	increase of free sugar content by 25.5 %	Cui and Zhao 1994
		REE nitrate	increase of total amino acids by 16.2 %	Cui and Zhao 1994
		La	decreased root growth by 28 - 55 %	Liu and Hasenstein 2005
		La	increase of root growth by 10 %	Liu and Hasenstein 2005
		La (0.63 μ M)	increase of the dry mass of roots by 36 %	Diatloff <i>et al.</i> 1995a
		Ce (0.63 μ M)	increase of root growth	Diatloff <i>et al.</i> 1995a
Wheat	6 - 15	REE	tendency of increased lysine content in grain	Xiong 1995
		La (390 μ g kg ⁻¹)	twofold increase in the mass of spikes	Meehan <i>et al.</i> 1993
		La (5 - 8 μ M)	decrease in root elongation by 50 %	Delhaize <i>et al.</i> 1993
	6.3-12.6	La (20 - 60 mg kg ⁻¹)	–	Kogan and Skripka 1983
		La ₂ (CO ₃) ₃	–	
Rice	4.3 - 15.3	REE nitrate	increased mass of 1000 grain	Jie and Yu 1985
	5 - 15	REE	–	Xiong 1995
	6.5 - 7	REE	increased mass of 1000 grain, increase of number of tillers and tassels	Yu 995, Guo and Zhu 1988
		REE	increase of root volume (0.94 - 5.4 %), increase of mass of roots (8.5 %), increase of root activity (20 %)	Wang, and Huang 1985
Barley	18.6	REE	–	Xia and He 1997
	18 - 19	La	increase of tiller production under water stress conditions (33 %)	Reddy <i>et al.</i> 2001
		La (0.5 - 1 mg dm ⁻³)	increase of dry matter (48 - 90 %), increase of leaf widths (14 -16 %), increase of stem widths (8 - 26 %), darker green foliage, delayed senescence, stronger tiller	Meehan <i>et al.</i> 2001
Sugar crops				
Sugar cane	8 - 20	REE	increase of sugar content (0.5 %)	Xiong 1995
	10-15	REE	–	Guo 1985
		REE	increased dry mass	Meehan <i>et al.</i> 1995
Sugar beet	8 - 15	REE	increase of sugar content (0.4 %)	Xiong 1995
	17-24	Ce (50 and 100 mg dm ⁻³)	–	Evanova 1964
		CeCl ₃	–	
	7	REE	increase of sugar content (5 %)	Guo <i>et al.</i> 1998
	REE	increase of root length (48 %), increase of plant height (32.4 %), increase of dry mass (10 - 55 %)	Feng 1987	
Industrial crops				
Rubber tree	6 - 20	REE	dry rubber reached the first grade	Xiong 1995
	8 - 10	REE	–	Guo 1985
Tobacco	7 - 16	REE	elevated grade rate of 10 %	Xiong 1995
	8 - 10	REE	–	Guo 1985
Soybean	6 - 12	REE	tendency of increasing protein and oil content	Xiong 1995
	8 - 9	REE	–	Qiao and Zhang 1989
Peanut	8 - 15	REE	–	Xiong 1995
	8 - 12	REE	–	Guo 1985
Cotton	5 - 12	REE	increase of mass of single boll (0.1 g), increase of span length of fibre (0.1 - 0.4 %)	Xiong 1995, Guo and Zhu 1988
		REE	–	Xia and He 1997
	5 - 10	La, Pr, mixed REE	improve biomass growth, increase root hair growth	Zhu and Zhang 1986

Ramine	7 - 15	REE	increase of fibre (10 - 15 %)	Xiong 1995
Flax	stem 8 - 12, seed 10 - 14	REE	increase of fibre (10 - 15 %)	Xiong 1995
Rape	14 - 24	REE	increase of oil content (2 %)	Xiong 1995
	4 - 48	REE	–	Ren and Xiao 1987, Cai and Jing 1989, Cai and Zheng 1990
	35 - 38	La (0.5 - 1 mg dm ⁻³)	increase in dry matter, increase of leaf area (20-50 %), advanced flowering and delayed wilting	Meehan <i>et al.</i> 1995
Fruits				
Apple Tree	10 - 22	REE	increase of sugar content (0.5-10 %), increase of vitamin C content (20 %), doubled cyanin content	Xiong 1995
Watermelon	8 - 12	REE	increase of sugar content (0.8 %)	Xiong 1995
	22.9	REE	increase of sugar content	Wan <i>et al.</i> 1998
Honey melon	75 - 111.4	REE	–	Wan <i>et al.</i> 1998
Grape	10 - 15	REE	increase of sugar content (20 %), increase of vitamin C content (20 %)	Xiong 1995
	8 - 12	REE	–	Xiong 1995
Chinese Gooseberry	10 - 25	REE	increase of sugar content (1.3 - 2.9 %), increase of vitamin C content	Xiong 1995
Banana	8 - 14	REE	increase of sugar content (3 - 4 %)	Xiong 1995, Guo 1993
		REE	increase of vitamin C content (4 - 6 %)	Xiong 1995
Orange	8 - 38	REE	increase of sugar content (0.6 %)	Wan <i>et al.</i> 1998
Litchi	14 - 17	REE	–	Guo 1985
Vegetables				
Potato	10 - 14	REE	increase of starch content (1 %)	Xiong 1995, Guo 1993
	5 - 6	REE	increase of tuber mass (13.8 %), increase of growth, increase of starch accumulation (1.5 %)	Jie 1987, Chen and Zheng 1990
Tomato	16	REE	–	Wan <i>et al.</i> 1998
Chinese Cabbage	10 - 20	REE	increase head-forming rate; 3.5 leaves/head	Xiong 1995, Guo 1985
Edible Fungus	10 - 30	REE	increase of amino acid content (40 %)	Xiong 1995
Mungbean		La (20 µM)	reduced shoot growth (60 %)	von Tucher <i>et al.</i> 2001
		La (< 0.19 µM)	increased dry mass of roots (21 %)	Diatloff <i>et al.</i> 1995b
		Ce (0.19 µM)	decreased dry mass of roots (26 %)	Diatloff <i>et al.</i> 1995b
			decreased dry mass of shoots 48 %, decrease of total dry mass (40 %)	
Pasture grasses				
Siberian Wild Ryegrass		REE	increase of hay (15-25 %); increase of crude protein (3-9 %), increase of yield of seed (10-15 %)	Xiong 1995
		REE 0.5-1 mg dm ⁻³	increase of in dry matter 22-78 %, increase of height (60 %)	Meehan <i>et al.</i> 1995
Alfalfa		REE	increase of hay (5.2-33 %); increase of crude protein (3-10 %), increase of yield of seed (10-15 %)	Xiong 1995
	17	REE	increase of grain mass (5 %)	Guo 1993

Table 4 Suppl. Production of secondary metabolites in plants treated with REEs (a - cell cultures; b - callus cultures).

Plant species	Secondary metabolites	Content/production of secondary metabolites	Increase of secondary metabolites	Elements	References
<i>Taxus yunnanensis</i> ^a	taxol	6.22 mg dm ⁻³	3-fold	La (5.80 μM)	Wu and Wang 2001
<i>Taxus chinensis</i> ^a	taxol	4.69 mg dm ⁻³		La (5.80 μM)	Wu and Wang 2001
<i>Crocus sativus</i> ^b	crocin	4.4 mg g ⁻¹	7.1-fold	La and Ce (either singly or a mixture); Ce (40 μM) ; La (60 μM) and Ce (20 μM)	Chen <i>et al.</i> 2004
<i>Cistanche deserticola</i> ^a	phenylethanoid glycosides	1.6 g dm ⁻³	117 and 167 %	La ₂ O ₃ :CeO ₂ :Pr ₆ O ₁₁ :Sm ₂ O ₃ = 255:175:3:1 (mol/mol)	Ouyang <i>et al.</i> 2003
<i>Saussurea medusa</i> ^b	flavonoids	27.5 mg per flask	70 - 100 %	Ce (0.05 mM)	Yuan <i>et al.</i> 2002
<i>Glycyrrhiza uralensis</i> ^b	flavonoids		2.7-fold	Eu (0.1 mg dm ⁻³)	Yang <i>et al.</i> 2005
<i>Tetrastigma hemsleyanum</i> ^a	flavonoids	47.5 and 48.5 mg g ⁻¹ (d.m.)	1.45 and 1.49-fold	Nd (200 μM) and Ce (200 μM)	Xin <i>et al.</i> 2013
<i>Catharanthus roseus</i> ^a	indole alkaloids		55 - 85	Ce ₂ O ₃ , CeCl ₃ , Y ₂ O ₃ , NdCl ₃	Zhao <i>et al.</i> 2000
	ajmalicine	40-51 mg dm ⁻³	9 - 11-fold	CeO ₂ , CeCl ₃ ; Y ₂ O ₃ ; NdCl ₃	Zhao <i>et al.</i> 2000
	catharanthine	36 and 31 mg dm ⁻³	30-fold and 25-fold	CeO ₂ and CeCl ₃	Zhao <i>et al.</i> 2000
<i>Rheum officinale</i> ^b	chrysophanol		130-fold	Eu (1 mg dm ⁻³)	Lu <i>et al.</i> 1998
	emodin		10-fold	Eu (1 mg dm ⁻³)	Lu <i>et al.</i> 1998