Manganese (Mn) is neurotoxic and can induce manganism, a Parkinson-like disease categorized as being a serious central nervous system irreversible neurodegenerative disease. An increased risk of developing symptoms of Parkinson disease has been linked to work-related exposure, for example, for workers in agriculture, horticulture, and people living near areas with frequent use of Mn-containing pesticides. In this study, the focus was placed on neurochemical effects of Mn. Rats were dosed intraperitoneally with 0.9% NaCl (control), 1.22 mg Mn (as MnO2)/kg bodyweight (bw)/day, or 2.5 mg Mn (as MnCl2)/kg bw/day for 7 d/wk for 8 or 12 weeks. This dosing regimen adds relevant new knowledge about Mn neurotoxicity as a consequence of low-dose subchronic Mn dosing. Manganese concentrations increased in the striatum, the rest of the brain, and in plasma, and regional brain neurotransmitter concentrations, including noradrenaline, dopamine (DA), 5-hydroxytryptamine, glutamate, taurine, and γ-aminobutyric acid, and the activity of acetylcholinesterase changed. Importantly, a target parameter for Parkinson disease and manganism, the striatal DA concentration, was reduced after 12 weeks of dosing with MnCl2. Plasma prolactin concentration was not significantly affected due to a potentially reduced dopaminergic inhibition of the prolactin release from the anterior hypophysis. No effects on the striatal α-synuclein and synaptophysin protein levels were detected.