Contents

I. General introduction ................................................................. 20
   I.1 Theory .............................................................................. 21
   I.2 Rationale ........................................................................ 22
   I.3 State of the art ................................................................. 24
      I.3.1 Biopurification system and biofilter.......................... 24
      I.3.2 The role of biomixtures in biopurification system ......... 25
      I.3.3 Biochar and Digestate as novel biomixtures .............. 26
      I.3.4 Stabilization mechanisms of natural, pyro (biochar) - bio (digestate) -
            genic organic matter ...................................................... 26
      I.3.5 Soil respiration as an indicator of pesticides degradation . 27
      I.3.6 Biochar and Digestate as adsorbents .......................... 28
   I.4 Objectives and outline of the thesis ...................................... 29

II. Microbial respiration of biochar- and digestate- based mixtures ......... 32
   II.1 Introduction .................................................................... 33
   II.2 Materials and methods ..................................................... 35
      II.2.1 Soils and organic amendments .................................. 35
      II.2.2 Preparation of soils with organic amendments .......... 36
      II.2.3 Measurement of microbial respiration ....................... 36
      II.2.4 Characterization of mixtures (DOC, SUVA\textsubscript{254} and pH measurement) .. 37
      II.2.5 DOC adsorption study ............................................. 40
      II.2.6 CO\textsubscript{2} flux calculation ...................................... 40
II.2.7 Kinetics of the carbon turnover .............................................. 41
II.2.8 Statistical analysis .......................................................... 41
II.3 Results and discussion ....................................................... 44
II.3.1 Cumulative CO₂-C releases ............................................. 44
II.3.2 CO₂ release with respect to C added ................................. 46
II.3.3 Carbon turnover kinetics ............................................... 48
II.3.4 Characterization of soil, biochar and digestate mixture ......... 50
II.3.5 Influence of DOC, SUVA and clay content on CO₂ evolution ... 51
II.4 Conclusions ........................................................................ 55

III. Dissipation of bentazone, pyrimethanil and boscalid in biochar and digestate based soil mixtures for biopurification systems ......................... 58
III.1 Introduction ........................................................................ 59
III.2 Material and methods ....................................................... 62
III.2.1 Substrates ...................................................................... 62
III.2.2 Pesticides ................................................................. 62
III.2.3 Characterization of used soil-mixtures ............................. 63
III.2.4 Mineralization/Dissipation experiments ......................... 66
III.2.5 Analytical procedures ................................................... 69
III.2.6 Pesticide mineralization/dissipation kinetics ................. 71
III.2.7 Goodness-of-fit statistics .............................................. 71
III.3 Results and discussion ..................................................... 72
III.3.1 Pesticide mineralization and kinetics .............................. 72
III.3.2 Pesticide dissipation and kinetics .................................. 77
III.3.3 Formation of non-extractable pesticide residues ............ 78
III.4 Summary and conclusion ................................................. 81

IV. Sorption-desorption behavior of three contrasting pesticides in biochar and digestate based soil mixtures for biopurification systems ......................... 82
IV.1 Introduction ....................................................................... 83
IV.2 Material and methods ....................................................... 85
IV.2.1 Substrates ..................................................................... 85
IV.2.2 Pesticides ............................................................... 86
IV.2.3 Characterization of used soil-bio mixtures .................... 86