

Table of contents

1	General introduction.....	1
1.1	Maize (<i>Zea mays</i> L.)	1
1.2	Potential and use of maize residues	2
1.3	Biochar production from maize residue via pyrolysis process	6
1.4	Problem statement.....	8
1.5	Objectives and outline of the studies	10
1.6	References.....	12
2	Part I: Effect of self-purging pyrolysis on yield of biochar from maize cobs, husks and leaves.....	18
2.1	Abstract.....	18
2.2	Introduction.....	18
2.3	Material and methods.....	20
2.3.1	Maize residues.....	20
2.3.2	Pyrolysis reactor and procedure	20
2.3.3	Characterisation of biomass and biochar	22
2.3.4	Design of experiments.....	24
2.3.5	Statistical analysis	24
2.4	Results and discussion	25
2.4.1	Characteristics of maize biomass and biochar	25
2.4.2	Effect of pyrolysis conditions on biochar yield	30
2.4.3	Biochar yield from maize cobs.....	34
2.4.4	Biochar yield from maize husks.....	36
2.4.5	Biochar yield from maize leaves.....	38
2.4.6	Comparison of biochar yield from cobs, husks and leaves	41
2.4.7	Biochar yield from self-purging and nitrogen purging pyrolysis.....	44
2.5	Conclusions.....	44
2.6	Appendix A. Supplementary data	46
2.7	References.....	47
3	Part II: Characterisation of biochar from maize residues produced in a self-purging pyrolysis reactor	50
3.1	Abstract.....	50

3.2	Introduction.....	50
3.3	Material and methods.....	52
3.3.1	Biomass and biochar preparation	52
3.3.2	Characterisation of biochars.....	53
3.3.3	Design of experiments.....	54
3.3.4	Statistical analysis	55
3.4	Results and discussion	55
3.4.1	Characteristics of the maize biomass and biochar samples.....	55
3.4.2	Volatile matter content of biochars	62
3.4.3	Ash content of biochars.....	66
3.4.4	pH and electrical conductivity of biochars.....	69
3.4.5	Optimal pyrolysis conditions	73
3.5	Conclusions.....	77
3.6	Appendix A. Supplementary data.....	79
3.7	References.....	83
4	Part III: Phytotoxicity of corncob biochar before and after heat treatment and washing.....	87
4.1	Abstract.....	87
4.2	Introduction.....	87
4.3	Material and methods.....	90
4.3.1	Biomass and biochar preparation	90
4.3.2	Characterisation of corncob biochar	91
4.3.3	Treatments of corncob biochar.....	92
4.3.4	Germination test	93
4.3.5	Statistical analysis	95
4.4	Results and discussion	95
4.4.1	Characteristics of corncob biochar	95
4.4.2	Effects of corncob biochar on cress seed germination.....	99
4.4.3	Effects of corncob biochar on shoot length.....	101
4.4.4	Effects of corncob biochar on shoot fresh weight.....	103
4.4.5	Effects of corncob biochar on dry matter content of the shoot biomass	105
4.4.6	Phytotoxic compounds in biochar	107
4.4.7	Effects of biochar treatments and application rates	107
4.5	Conclusions.....	110
4.6	References.....	112

5	General discussion.....	118
5.1	Self-purging pyrolysis of maize residues.....	118
5.2	Properties of biochars derived from self-purging pyrolysis	120
5.3	Phytotoxic effects of corncob biochar treatments on seed germination	122
5.4	Impact to practise	124
5.5	Further research requirements.....	124
5.6	References	125
	Summary	131
	Zusammenfassung	133
	Publications	135