

1 Introduction	6
2. Literature review	9
2.1 Adult click beetle taxonomy and distribution (<i>Agriotes</i> spp.)	9
2.2 Wireworm biology and life cycle	11
2.3 Wireworm damage to crops	13
2.4 Use of sex pheromone traps	16
2.5 Wireworm management options	18
3 Materials and methods	26
3.1 Biology of <i>Agriotes lineatus</i> and <i>Agriotes obscurus</i>	29
3.1.1 Laboratory experiment (vial test).....	29
3.1.1.1 Adults and egg collection.....	29
3.1.1.2 Larval development.....	30
3.1.1.3 Larval overwintering	31
3.1.2 Installation of rearing cages (semi-natural conditions).....	31
3.1.2.1 Introduction of adults into cages	31
3.1.2.2 Study of larval development.....	32
3.1.3 Microscopic identification.....	33
3.2 Range of attraction of pheromone traps (Mark-release-recapture)	35
3.2.1 Insect material	35
3.2.2 Marking and release of beetles.....	35
3.3 Prevention trial	37
3.3.1 Experimental design.....	37
3.3.2 Pheromone traps installation	37
3.3.3 Soil sampling and wireworm extraction procedure.....	39
3.3.4 Damage assessment in potatoes	42
3.4 Effect of <i>Naturalis</i> (<i>Beauveria bassiana</i>) as a biological control for wireworms.....	43
3.4.1 Laboratory experiments.....	43
3.4.1.1 Wireworm collection and selection.....	43
3.4.1.2 <i>Beauveria bassiana</i> seed coat application.....	43
3.4.2 Field experiments	44
3.4.2.1 Experimental design and application of naturalis.....	44
3.5 Statistical analysis	45
4 Results	46

4.1 Beetle collection and morphology.....	46
4.2 Biology of <i>Agriotes lineatus</i> and <i>Agriotes obscurus</i>	47
4.2.1 Life cycle of <i>A. obscurus</i> under laboratory conditions	47
4.2.1.1 Eggs	47
4.2.1.1 Egg morphology and distribution.....	47
4.2.1.1.1 Embryonic development and egg viability	48
4.2.1.2 Larvae.....	49
4.2.1.2 Larval instars and development.....	49
4.2.1.2.1 Larvae survival	52
4.2.1.3 Overwintering in field soil.....	53
4.2.1.4 Pupae	53
4.2.2 Life cycle of <i>A. obscurus</i> and <i>A. lineatus</i> in semi-natural conditions in rearing cages	56
4.2.2.1 Eggs	56
4.2.2.2 Larvae development	56
4.2.2.3 Larval population density in rearing cages.....	57
4.2.2.4 <i>Agriotes obscurus</i> development in the laboratory and field	59
4.3 Range of attraction of pheromone traps (Mark-release-recapture)	61
4.3.1 Total recapture of <i>A. lineatus</i> and <i>A. obscurus</i> males	61
4.3.2 Recapture of <i>A. lineatus</i>	63
4.3.3 Recapture of <i>A. obscurus</i>	65
4.3.4 Maximum sampling range and effective sampling area.....	66
4.4 Prevention trial (Mass trapping).....	68
4.4.1 Male trapping	68
4.4.2 Wireworm population	74
4.4.3 Wireworm damage	77
4.5 Effect of <i>Naturalis (Beauveria bassiana)</i> as a biological control for wireworms.....	79
4.5.1 Laboratory experiment	79
4.5.2 Field experiment.....	80
5 Discussion	81
5.1 Biology of <i>A. lineatus</i> and <i>A. obscurus</i>	81
5.2 Range of attraction of sex pheromone traps.....	85

5.3 Use of pheromones for male trapping	88
5.4 Effectiveness of <i>Beauveria bassiana</i>	91
5.5 Outlook.....	92
6 References	94
7 List of Figures	119
8 List of Tables.....	122