Contents

Chapter 1	I
1. General introduction	2
1.1 Breeding for N efficient cultivars	
1.2 Reproductive growth phase is critical for N efficiency	4
1.3 Effect of genotypic variation in sulfur distribution on N efficiency	5
1.4 Effect of genotypic variation in branching on N efficiency	
1.5 Objectives N efficient cultivars	8
References	9
Chapter 2	16
2. Sulfur metabolism of winter oilseed rape cultivars is differentially affected by N	
deficiencydeficiency	17
Abstract	18
Introduction	19
Material and Methods	22
Results	24
Discussion	27
Acknowledgments	29
References	30
Figure and table legends	34
Figure	35
Tables	36
Chapter 3	39
3. Genotypic variation in leaf sulfur metabolites in oilseed rape in relation to nitrog	en
remobilization	40
Abstract	41
Introduction	42
Material and Methods	44
Results	48
Discussion	51
Acknowledgments	
References	57
Figure legends	62
Figures	64
Chapter 4	71
4. Double low cultivars of oilseed rape (Brassica napus L.) perform better in nitroge	en and
sulfur efficiency than high glucosinolate cultivars	72
Abstract	
Introduction	74
Material and Methods	76

Results	78
Discussion	82
Acknowledgments	85
References	86
Figure legends	90
Figures	92
Chapter 5	97
5. Genotypic variation in nitrogen efficiency and remobilization of oilseed rape cult	tivars
differing in plant architecture	
Abstract	99
Introduction	100
Material and Methods	103
Results	107
Discussion	113
Acknowledgments	120
References	121
Figure and table legends	126
Figures	128
Tables	133
Figures	128
Chapter 6	141
6. General discussion	142
6.1. Sulfate accumulation is the crucial factor constraining S distribution into	
developing organs under low N conditions	142
6.2. High S distribution into developing organs is not beneficial for reproductive	growth
6.3. Optimum branching is crucial for high N efficiency	145
6.4. Conclusions and perspective	146
References	148
Chapter 7	151
7. Summary/Zusammenfassung	151
7.1. Summary	152
7.2. Zusammenfassung	154