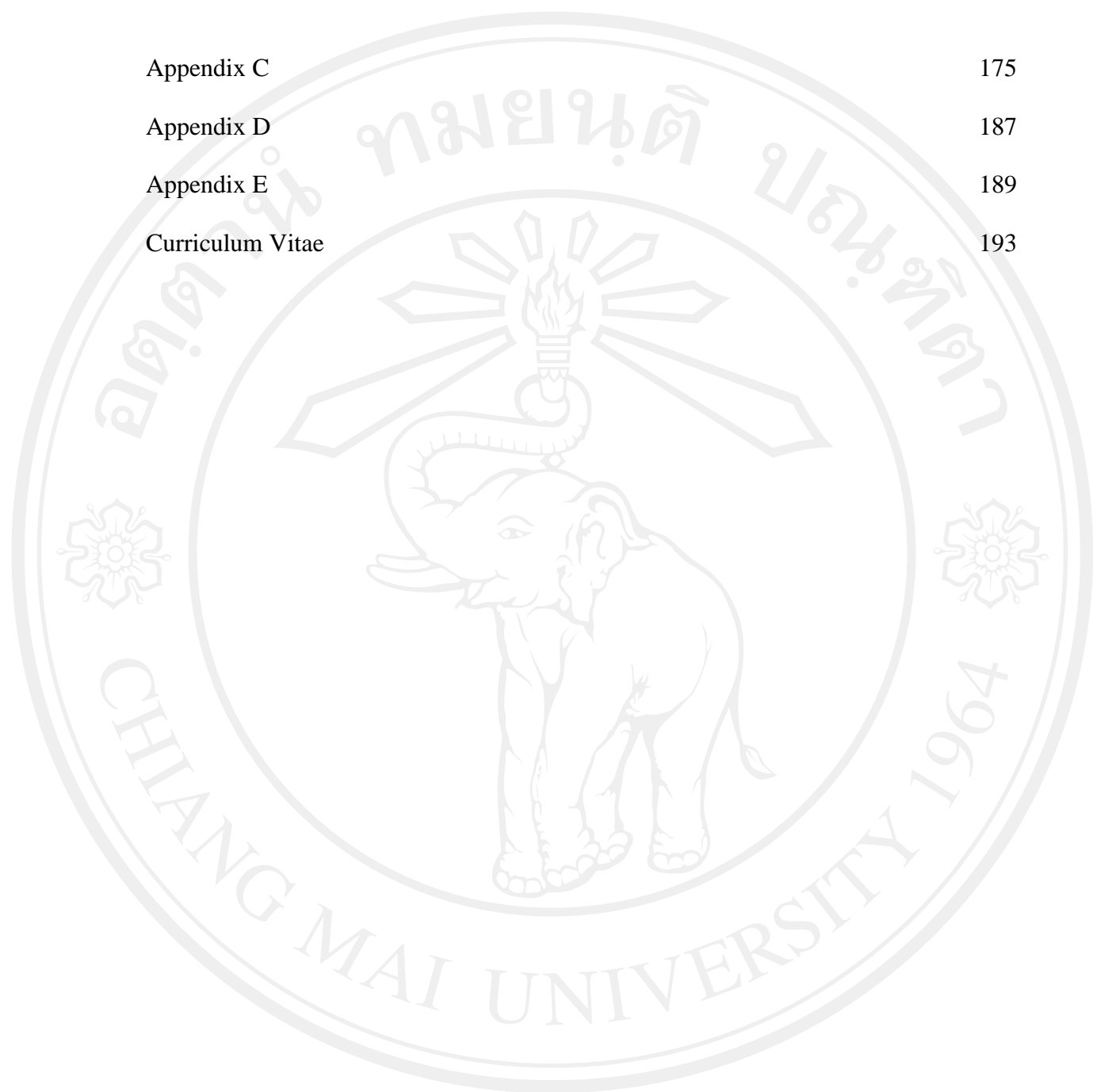


## Table of contents

	Page
Acknowledgments	iii
Abstract (English)	iv
Abstract (Thai)	vi
Table of Contents	viii
List of Tables	x
List of Figures	xiv
Chapter 1 Introduction	1
Chapter 2 Literature review	5
2.1 Origin and production of pea	5
2.2 Genetic basis for powdery disease resistance	14
2.3 Breeding for powdery mildew disease resistance in pea	17
2.4 Marker-assisted selection in breeding for disease resistance	20
Chapter 3 Material and methods	29
Chapter 4 Results	45
Chapter 5 Discussions	109
Chapter 6 Conclusion and Recommendations	126
References	132
Appendices	144
Appendix A	145
Appendix B	150

Appendix C	175
Appendix D	187
Appendix E	189
Curriculum Vitae	193



ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่

Copyright© by Chiang Mai University  
All rights reserved

## List of Tables

<b>Table</b>		<b>Page</b>
3.1	Source of pea lines/cultivar, types and powdery mildew phenotypes	29
3.2	Classification scale of powdery mildew disease severity group on Young <i>et al.</i> , (1993) and Ondrej <i>et al.</i> (2003)	31
3.3	Primer types, sequence and linkage DNA marker position reported by Janila and Sharma (2004)	33
3.4	Parental lines/cultivar and crosses including reciprocal crosses of powdery mildew resistant and susceptible lines/cultivar	36
3.5	Example of questionnaire done by consumers	44
4.1	Morphological characteristics and number of days on first flowering, blooming, pod setting and first flowering node of 7 pea lines/cultivar which were grown at Pang Da Royal Agricultural Station	46
4.2	Heights, nodes and branches number of 7 pea lines/cultivar	51
4.3	Length, width of fresh and dry pod, seed numbers per pod of 7 pea lines/cultivar	53
4.4	DNA bands of 7 snow pea lines/cultivar generated by SCAR primer ScOPD-10	61
4.5	DNA bands of 7 snow pea lines/cultivar generated by random primer OPU-17	62
4.6	DNA bands of 7 snow pea lines/cultivar generated by random primer OPO-02	63

4.7	Description of three specific bands comparing with NCBI database	64
4.8	Evaluation of powdery mildew resistance by DNA marker	71
4.9	Number of flowering, blooming and first pod setting days of tested pea at Khun Wang Royal Project Development Centre during May to August 2010	79
4.10	The average of vines height, first flowering node, number of flower per inflorescence, first pod setting and pod per inflorescence of tested snow pea at Khun Wang Royal Project Development Centre from May to August 2010	81
4.11	The average number of first branch, number of branch per plant, internodes length and number of node per plant of tested snow pea at Khun Wang Royal Project Development Centre during May to August 2010	83
4.12	First harvesting date and number of day to harvest of tested snow pea at Khun Wang Royal Project Development Centre during May to August 2010	84
4.13	Pod length and width, number of seeds per pod and pod weight of tested snow pea at Khun Wang Royal Project Development Centre during May to August 2010	87
4.14	Number of pod and pod weight per plant of tested snow pea at Khun Wang Royal Project Development Centre during May to August 2010	88

- 4.15 Number of day to first flowering, blooming and first pod setting of tested snow pea at Ang Khang Royal Agricultural Station during August to October 2010 90
- 4.16 The average of vine height, first flowering node, number of flower per inflorescences, first node to pod setting and pod per inflorescences of tested snow pea at Ang Khang Royal Agricultural Station during August to October 2010 92
- 4.17 Number of node to first branch, number of branch per plant and internode length of tested snow pea at Ang Khang Royal Agricultural Station during August to October 2010 93
- 4.18 First harvesting date and number of day to harvest of tested snow pea at Ang Khang Royal Agricultural Station during August to October 2010 95
- 4.19 Pod length and width, number of seeds per pod and pod weight of tested snow pea at Ang Khang Royal Agricultural Station during August to October 2010 98
- 4.20 Number of pod, total pod weight per plant of tested snow pea at Ang Khang Royal Agricultural Station during August to October 2010 99
- 4.21 Consumer preference to characteristics of tested snow pea lines/cultivar from Khun Wang Royal Project Development Centre 107
- 4.22 Consumer preference to characteristics of tested snow pea lines/cultivar from Ang Khang Royal Agricultural Station 107

## List of Figures

<b>Figure</b>		<b>Page</b>
2.1	Powdery mildew diseases infected on pea	11
2.2	Characteristics of powdery mildew	12
3.1	The percentage of powdery mildew infection area on pea leaves	32
4.1	Flower characteristics of pea lines/cultivar	48
4.2	Pod characteristics of 7 pea lines/cultivar	49
4.3	Powdery mildew infection percentage on leaf surface area at various node positions in 7 pea lines/cultivar which was conducted in the field condition at Pang Da Royal Agricultural Station in winter season during November 2006 to March 2007	55
4.4	Powdery mildew resistance evaluation of 7 pea lines/cultivar at 65 day after transplanting, in the field condition at Pang Da Royal Agricultural Station in winter season during November 2006 to March 2007	56
4.5	Powdery mildew disease infections on pea leaves at the 11 <sup>th</sup> node of 7 pea lines/cultivar at 65 days after transplanting which was conducted in field condition at Pang Da Royal Agricultural Station in winter season during November 2006 to March 2007	56
4.6	Powdery mildew infection percentage on leaf surface area at various node positions in 7 pea lines/cultivar which was conducted under the greenhouse at Inthanon Royal Agricultural Research Station in rainy season during August to October 2008	58

- 4.7 Powdery mildew resistance evaluation plot of 7 pea lines/cultivar 59  
at 30 days after transplanting, under greenhouse condition at  
Inthanon Royal Agricultural Research Station during August to  
October 2008
- 4.8 Powdery mildew resistance evaluation plot of 7 pea lines/cultivar 59  
at 75 days after transplanting, under greenhouse condition at  
Inthanon Royal Agricultural Research Station during August to  
October 2008
- 4.9 PCR profiles of 7 snow pea lines/cultivar, 3 of powdery mildew 61  
resistant lines, P117, P185 and P309, and 4 of powdery mildew  
susceptible lines/cultivar, No.3, No.4, No.5 and Fang No.7,  
amplified by SCAR primer ScOPD-10
- 4.10 PCR profiles of 7 snow pea lines/cultivar, 3 of powdery mildew 62  
resistant lines, P117, P185 and P309, and 4 of powdery mildew  
susceptible lines/cultivar, No.3, No.4, No.5 and Fang No.7,  
amplified by random primer OPU-17
- 4.11 PCR profiles of 7 snow pea lines/cultivar, 3 of powdery mildew 63  
resistant lines, P117, P185 and P309, and 4 of powdery mildew  
susceptible lines/cultivar, No.3, No.4, No.5, and Fang No.7,  
amplified by random primer OPO-02
- 4.12 DNA sequence of the specific band of line P117 65
- 4.13 DNA sequence of the specific band of line P185 65
- 4.14 DNA sequence of the specific band of line P309 66



4.15	Pod characteristics of F <sub>1</sub> hybrid derived from different crosses	67
4.16	Evaluation of resistance by using snow pea stem character; A) resistant to powdery mildew disease and B) susceptible to powdery mildew disease	68
4.17	PCR profiles of line No.3 (female parent), line P309 (male parent), and their 10 powdery mildew resistant F <sub>2</sub> hybrids generated by SCAR primer ScOPD-10	72
4.18	PCR profiles of line P309 (female parent), line No.4 (male parent), and their 10 powdery mildew resistant F <sub>2</sub> hybrids generated by SCAR primer ScOPD-10	72
4.19	PCR profiles of cultivar Fang No.7 (female parent), line P309 (male parent), and their 19 powdery mildew resistant F <sub>2</sub> hybrids generated by SCAR primer ScOPD-10	72
4.20	PCR profiles of line No.3 (female parent), line P309 (male parent), and their 10 powdery mildew resistant BC <sub>1</sub> F <sub>2</sub> hybrids generated by SCAR primer ScOPD-10	73
4.21	PCR profiles of line P309 (female parent), line No.4 (male parent), and their 10 powdery mildew resistant BC <sub>1</sub> F <sub>2</sub> hybrids generated by SCAR primer ScOPD-10	73
4.22	PCR profiles of line No.5 (female parent), line P309 (male parent), and their 9 powdery mildew resistant BC <sub>1</sub> F <sub>2</sub> hybrids generated by SCAR primer ScOPD-10	74
4.23	PCR profiles of cultivar Fang No.7 (female parent), line P309 (male parent), and their 17 powdery mildew resistant BC <sub>1</sub> F <sub>2</sub> hybrids generated by SCAR primer ScOPD-10	74



- 4.24 PCR profiles of line No.3 (female parent), line P309 (male parent), 75  
and their 10 powdery mildew resistant BC<sub>2</sub>F<sub>2</sub> hybrids generated by  
SCAR primer ScOPD-10
- 4.25 PCR profiles of line P309 (female parent), line No.4 (male parent), 75  
and their 10 powdery mildew resistant BC<sub>2</sub>F<sub>2</sub> hybrids generated by  
SCAR primer ScOPD-10
- 4.26 PCR profiles of line No.3 (female parent), line P309 (male parent), 76  
and their 8 powdery mildew resistant BC<sub>3</sub>F<sub>2</sub> hybrids generated by  
SCAR primer ScOPD-10
- 4.27 PCR profiles of line P309 (female parent), line No.4 (male parent), 76  
and their 10 powdery mildew resistant BC<sub>3</sub>F<sub>2</sub> hybrids generated by  
SCAR primer ScOPD-10
- 4.28 PCR profiles of line No.5 (female parent), line P309 (male parent), 77  
and their 9 powdery mildew resistant BC<sub>3</sub>F<sub>2</sub> hybrids generated by  
SCAR primer ScOPD-10
- 4.29 PCR profiles of cultivar Fang No.7 (female parent), line P309 77  
(male parent), and their 6 powdery mildew resistant BC<sub>3</sub>F<sub>2</sub> hybrids  
generated by SCAR primer ScOPD-10
- 4.30 Pod characteristics of snow pea lines/cultivar and BC<sub>3</sub>F<sub>3</sub> progenies 85  
at Khun Wang Royal Project Development Centre during May to  
August 2010

- 4.31 Pods characteristics of snow pea lines/cultivar and BC<sub>3</sub>F<sub>3</sub> 96  
progenies at Ang Khang Royal Agricultural Station during August  
to October 2010
- 4.32 Powdery mildew infection percentage on leaf surface area at the 101  
node positions in snow pea lines/cultivar which was conducted in  
the greenhouse condition at Khun Wang Royal Project  
Development Centre during May to August 2010
- 4.33 Powdery mildew infection percentage on leaf surface area at 103  
various node positions in snow pea lines/cultivar which was  
conducted in the field condition at Ang Khang Royal Agricultural  
Station during August to October 2010
- 4.34 The weight different among the mean of each trait on polar plot for 108  
the sensory comparison profile