

Claims

1. A method of using a DNA molecule comprising a nucleotide sequence encoding an elicitin protein operably linked to and expressed under the regulatory control of an inducible transcription regulatory element to produce a transgenic plant with improved disease resistance, said method comprising the steps of:

(a) providing a nucleotide sequence encoding a heterologous coding sequence of an elicitin protein operably linked to an inducible transcription regulatory element and a promoter functional in a plant cell to produce an inducible expression construct;

(b) cloning the inducible expression construct of step (a) into a plasmid vector adapted for use in a plant cell to produce an inducible expression vector;

(c) introducing said inducible expression vector of step (b) into a plant tissue to produce transgenic plant tissue; and

(d) regenerating said transgenic plant tissue to produce a transgenic plant, whereby said elicitin is expressed in response to potential plant pathogen invasion or elicitor treatment of said transgenic plant, thereby inducing the hypersensitive response, increasing the resistance of said transgenic plant to a plant pathogen.

2. The method of claim 1, wherein said inducible transcription regulatory element comprises a nucleotide sequence as given in SEQ ID NO:2 from nucleotide 458 to nucleotide 473; a nucleotide sequence as given in SEQ ID NO:2 from nucleotide 406 to nucleotide 473; or a nucleotide sequence as given in SEQ ID NO:2 from nucleotide 371 to nucleotide 473.

3. The method of claim 1, wherein said transgenic plant is a dicot, monocot, gymnosperm, or conifer.

4. The method of claim 3, wherein said transgenic plant is a member of the Solanaceae.

5. The method of claim 4, wherein said elicitin protein is a fungal or bacterial elicitin.

6. The method of claim 5, wherein said fungal elicitin is from *Phytophthora*.

7. The method of claim 5, wherein said elicitin protein comprises a ParA1, cryptogein, pariscein, or harpin protein.

8. The method of claim 1, wherein said elicitin coding sequence has at least 70% nucleotide sequence homology to a *parA1* coding sequence as given in SEQ ID NO:12 from nucleotide 207 to nucleotide 563 and encodes a functional elicitin protein; encodes a ParA1 protein having an amino acid sequence as given in SEQ ID NO:13; or is a *parA1* coding sequence as given in SEQ ID NO:12 from nucleotide 207 to nucleotide 563.

9. A transgenic plant (a seed or a cell thereof) comprising a sequence encoding an elicitin, said coding sequence being operably linked to an inducible transcriptional regulatory element and a promoter functional in a plant, wherein said plant expresses said elicitin coding sequence in response to invasion of said plant by a potential plant pathogen or in response to treatment with an elicitor or other inducing chemical signal.

10. The transgenic plant of claim 9, wherein said inducible transcription regulatory element comprises a nucleotide sequence as given in SEQ ID NO:2 from nucleotide 458 to nucleotide 473; a nucleotide sequence as given in SEQ ID NO:2 from nucleotide 406 to nucleotide 473; or a nucleotide sequence as given in SEQ ID NO:2 from nucleotide 371 to nucleotide 473.

11. The transgenic plant of claim 9, wherein said transgenic plant is a dicot, monocot, conifer, or gymnosperm.

12. The transgenic plant of claim 11, wherein said transgenic plant is a member of the Solanaceae.

13. The transgenic plant of claim 12, wherein said transgenic plant is *Nicotiana tabacum*.

14. The transgenic plant of claim 9, wherein said elicitin is a fungal or bacterial elicitin.

15. The transgenic plant of claim 14, wherein said fungal elicitin is from *Phytophthora*.

16. The transgenic plant of claim 14, wherein said elicitin comprises a ParA1, cryptogein, pariscein, or harpin protein.

17. The transgenic plant of claim 1, wherein said elicitin coding sequence has at least 70% nucleotide sequence homology to a *parA1* coding sequence as given in SEQ ID NO:12 from nucleotide 207 to nucleotide 563 and encodes a functional elicitin protein; encodes a ParA1 protein having an amino acid sequence as given in SEQ ID NO:13; or is a *parA1* coding sequence as given in SEQ ID NO:12 from nucleotide 207 to nucleotide 563.

18. A method of producing a transgenic plant having greater resistance to disease than a corresponding parental plant, said method comprising the steps of:

(a) introducing a nucleotide sequence encoding a heterologous coding sequence of an elicitin protein operably linked to an inducible transcription regulatory element and a promoter functional in a plant cell into a plant cell or plant tissue;

(b) regenerating a transgenic plant from the transgenic plant cell or tissue of step (a); and

(c) growing the transgenic plant under conditions which allow the expression of said nucleotide sequence when said transgenic plant is invaded by a potential plant pathogen capable of infecting a corresponding parent plant, whereby the expression of said elicitin is induced with the result that a resistance response is induced in response to an invading potential plant pathogen.

19. The method of claim 18, wherein said inducible transcription regulatory element comprises a nucleotide sequence as given in SEQ ID NO:2 from nucleotide 458 to nucleotide 473; a nucleotide sequence as given in SEQ ID NO:2 from nucleotide 406 to nucleotide 473; or a nucleotide sequence as given in SEQ ID NO:2 from nucleotide 371 to nucleotide 473.

20. The method of claim 18, wherein said transgenic plant is a dicot, monocot, gymnosperm, or conifer.

21. The method of claim 20, wherein said transgenic plant is a member of the Solanaceae.

22. The method of claim 21, wherein said transgenic plant is *Nicotiana tabacum*.

23. The method of claim 18, wherein said elicitin is a fungal or bacterial elicitin.

24. The method of claim 23, wherein said fungal elicitin is from *Phytophthora*.

25. The method of claim 23, wherein said elicitor protein comprises a ParA1, cryptogein, pariscein, or harpin protein.

26. The method of claim 18, wherein said elicitor coding sequence has at least 70% nucleotide sequence homology to a *parA1* coding sequence as given in SEQ ID NO:12 from nucleotide 207 to nucleotide 563 and encodes a functional elicitor protein; encodes a ParA1 protein having an amino acid sequence as given in SEQ ID NO:13; or is a *parA1* coding sequence as given in SEQ ID NO:12 from nucleotide 207 to nucleotide 563.

27. A transgenic plant (or a seed or cell thereof) genetically engineered to contain a chimeric gene comprising an inducible transcription regulatory element, a promoter functional in a plant and a coding sequence not naturally associated with said inducible transcription regulatory element, said coding sequence being expressed under the regulatory control of said inducible transcription regulatory element.

28. The transgenic plant of claim 27, wherein said inducible transcription regulatory element is comprises a nucleotide sequence as given in SEQ ID NO:2 from nucleotide 458 to nucleotide 473; a nucleotide sequence as given in SEQ ID NO:2 from nucleotide 406 to nucleotide 473; or a nucleotide sequence as given in SEQ ID NO:2 from nucleotide 371 to nucleotide 473.

29. The transgenic plant claim 27, wherein said promoter functional in a plant cell is the Cauliflower Mosaic Virus 35S gene minimal promoter.

30. The transgenic plant of claim 27, wherein said transgenic plant is a dicot, monocot, gymnosperm, or conifer.

31. The transgenic plant of claim 30, wherein said transgenic plant is a member of the Solanaceae.

32. The transgenic plant of claim 31, wherein said transgenic plant is *Nicotiana tabacum*.

33. A recombinant nucleic acid molecule comprising an inducible plant disease-resistance regulatory element.

34. The nucleic acid molecule of claim 33, wherein said regulatory element is obtained from a gene encoding a terpene or a sesquiterpene cyclase.

35. The nucleic acid molecule of claim 33, wherein said regulatory element directs expression of an epi-5-aristolochene synthase (EAS).

36. The nucleic acid molecule of claim 33, said nucleic acid molecule comprising the nucleotide sequence shown in Fig. 3A (SEQ ID NO: 14) or an inducible plant disease-resistance fragment thereof; the nucleotide sequence shown in Fig. 3A (SEQ ID NO: 14); the nucleotides 463-473 of SEQ ID NO: 2; nucleotides 406-486 of SEQ ID NO: 2; nucleotides 463-572 of SEQ ID NO: 2; the nucleotides 371-463 of SEQ ID NO: 2; or the nucleotides 411-457 of SEQ ID NO: 2.

37. The nucleic acid molecule of claim 33, wherein a heterologous coding sequence is operably linked downstream of and under the regulatory control of said inducible transcription regulatory element.

38. The nucleic acid molecule of claim 37, wherein said heterologous coding sequence encodes an elicitor protein.

39. The nucleic acid molecule of claim 38, wherein said heterologous coding sequence encodes an elicitor of *Phytophthora parasitica*.

40. The nucleic acid molecule of claim 39, wherein said elicitor of *Phytophthora parasitica* is the ParA1 elicitor protein.

41. The nucleic acid molecule of claim 33, wherein said nucleic acid molecule is obtained from a dicot, monocot, gymnosperm, or conifer.

42. The nucleic acid molecule of claim 41, wherein said dicot is a member of the *Solanaceae*.

43. The nucleic acid molecule of claim 42, wherein said Solanaceous plant is a member of the genus *Nicotiana*.

44. A vector comprising the DNA of claim 33.

45. The vector of claim 44, said vector being capable of inducibly regulating the expression of a nucleotide sequence in a vector-containing cell.

46. The vector of claim 45, said nucleotide sequence coding for a heterologous polypeptide.

47. The vector of claim 46, wherein said heterologous peptide is a pharmaceutical protein.

48. A transgenic plant (or a seed or cell thereof) that contains a nucleic acid molecule of claim 33 integrated into the genome of said plant.

49. A non-naturally occurring DNA molecule comprising a transcription-enhancing element having a nucleotide sequence as given in SEQ ID NO:2 from nucleotide 371 to nucleotide 463.

50. A non-naturally occurring DNA molecule comprising a transcription-enhancing sequence having a nucleotide sequence as given in SEQ ID NO:2 from nucleotide 1 to nucleotide 463.

51. A method of increasing the transcriptional expression of a downstream DNA sequence in a transgenic plant cell, said method comprising the steps of:

(a) operably linking a transcription-enhancing element having a nucleotide sequence substantially as given in SEQ ID NO:2 from nucleotide 371 to nucleotide 463 to a promoter functional in a plant cell, said promoter being operably linked to a downstream DNA sequence for which transcriptional expression is to be directed to produce an enhanced expression cassette; and

(b) introducing the enhanced expression cassette of step (a) into a plant cell to produce a transgenic plant cell.

52. The method of claim 51, wherein said transcription enhancing sequence further comprises a nucleotide sequence as given in SEQ ID NO:2 from nucleotide 1 to 370 operably linked immediately upstream of the transcription-enhancing sequence of step (a).

53. The method of claim 51, wherein said promoter functional in a plant cell is a minimal promoter of Cauliflower Mosaic Virus.