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(54) Title: GENETIC LOCI ASSOCIATED WITH IRON DEFICIENCY TOLERANCE IN SOYBEAN

(57) Abstract: The invention relates to methods and compositions for identifying soybean plants that are tolerant, have improved tolerance or are susceptible to iron deficient growth conditions. The methods use molecular genetic markers to identify, select and/or construct disease-tolerant plants or identify and counterselect disease-susceptible plants. Soybean plants that display tolerance or improved tolerance to Phytophthora root rot infection that are generated by the methods of the invention are also a feature of the invention.



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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2005/028227

A. CLASSIFICATION OF SUBJECT MATTER

INV. C12N15/82

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C12N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, BIOSIS, WPI Data, PAJ, EMBASE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CHARLSON DIRK V ET AL: "Associating SSR markers with soybean resistance to iron deficiency chlorosis." JOURNAL OF PLANT NUTRITION, vol. 26, no. 10-11, November 2003 (2003-11), pages 2267-2276, XP009064632 ISSN: 0190-4167 abstract page 2268, line 5 - line 9 page 2269, line 11 - line 14 page 2272, line 18 - page 2273, line 2 table 3 ----- -/--	1-45

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

4 April 2006

Date of mailing of the international search report

11.09.06

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2005/028227

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LIN S ET AL: "Mapping genetic loci for iron deficiency chlorosis in soybean" MOLECULAR BREEDING, vol. 3, no. 3, 1997, pages 219-229, XP002375567 ISSN: 1380-3743 cited in the application abstract table 1 figure 2 table 2	1-45
X	LIN SHUN FUN ET AL: "Nutrient solution screening of Fe chlorosis resistance in soybean evaluated by molecular characterization" JOURNAL OF PLANT NUTRITION, vol. 23, no. 11-12, November 2000 (2000-11), pages 1915-1928, XP009064629 ISSN: 0190-4167 abstract table 3 table 4	1-45
X	LIN SHUN FUN ET AL: "Molecular characterization of iron deficiency chlorosis in soybean" JOURNAL OF PLANT NUTRITION, vol. 23, no. 11-12, November 2000 (2000-11), pages 1929-1939, XP009064630 ISSN: 0190-4167 cited in the application abstract page 1931, line 13 - line 18 page 1934, line 20 - line 23 table 2 page 1936, line 3 - page 1937	1-45
A	CREGAN P B ET AL: "An integrated genetic linkage map of the soybean genome" CROP SCIENCE, CROP SCIENCE SOCIETY OF AMERICA, MADISON, WI, US, vol. 39, no. 5, September 1999 (1999-09), pages 1464-1490, XP002309701 ISSN: 0011-183X the whole document	1-45
X	US 6 326 529 B1 (FREESTONE ROBERT E) 4 December 2001 (2001-12-04) the whole document	20

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2005/028227

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 284 950 B1 (STREIT LEON GEORGE) 4 September 2001 (2001-09-04) the whole document -----	20
X	US 6 235 976 B1 (MUELLER ERVIN HENRY) 22 May 2001 (2001-05-22) the whole document -----	20
X	US 6 166 296 A (FREESTONE ET AL) 26 December 2000 (2000-12-26) the whole document -----	20
X	US 5 917 130 A (GEBHARDT ET AL) 29 June 1999 (1999-06-29) the whole document -----	20
X	US 5 767 349 A (MATSON ET AL) 16 June 1998 (1998-06-16) the whole document -----	20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2005/028227

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-45 (all partially)

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-45 (all partially)

Methods of identifying a soybean plant or germplasm that displays tolerance, improved tolerance or susceptibility to iron deficiency comprising detecting in said soybean at least one allele of one or more of the marker locus S60210-TB, SAC1006 or SATT391 (linkage group C1), introgressed soybean plants or germplasms identified by said methods. Methods of producing a soybean plant having tolerance or improved tolerance to low iron growth conditions comprising introducing an exogenous nucleic acid into a target soybean plant or progeny thereof, wherein said nucleic acid sequence is linked to at least one favorable allele of S60210-TB, SAC1006 or SATT 391.

Systems for identifying a soybean plant predicted to have tolerance, improved tolerance or susceptibility to low iron growth conditions, the system comprising a set of marker probes or primers configured to detect at least one favorable allele of one marker locus selected from S60210-TB, SAC1006 and ATT391.

Compositions comprising an amplification primer pair capable of initiating DNA polymerization by DNA polymerase on a soybean nucleic acid template to generate a soybean marker amplicon corresponding to S60210-TB.

2. claims: 1-43 (all partially)

Methods of identifying a soybean plant or germplasm that displays tolerance, improved tolerance or susceptibility to iron deficiency comprising detecting in said soybean at least one allele of one or more of the marker locus SAC1724, SATT307 and P13073A-1 (linkage group C2), introgressed soybean plants or germplasms identified by said methods. Methods of producing a soybean plant having tolerance or improved tolerance to low iron growth conditions comprising introducing an exogenous nucleic acid into a target soybean plant or progeny thereof, wherein said nucleic acid sequence is linked to at least one favorable allele of SAC1724, SATT307, P13073A-1.

Systems for identifying a soybean plant predicted to have tolerance, improved tolerance or susceptibility to low iron growth conditions, the system comprising a set of marker probes or primers configured to detect at least one favorable allele of one marker locus selected from SAC1724, SATT307 and P13073A-1.

3. claims: 1-43 (all partially)

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Methods of identifying a soybean plant or germplasm that displays tolerance, improved tolerance or susceptibility to iron deficiency comprising detecting in said soybean at least one allele of one or more of the marker locus P10598A-1, SATT334, SATT510 and SATT335 (linkage group F), introgressed soybean plants or germplasms identified by said methods. Methods of producing a soybean plant having tolerance or improved tolerance to low iron growth conditions comprising introducing an exogenous nucleic acid into a target soybean plant or progeny thereof, wherein said nucleic acid sequence is linked to at least one favorable allele of P10598A-1, SATT334, SATT510 and SATT335. Systems for identifying a soybean plant predicted to have tolerance, improved tolerance or susceptibility to low iron growth conditions, the system comprising a set of marker probes or primers configured to detect at least one favorable allele of one marker locus selected from P10598A-1, SATT334, SATT510 and SATT335.

4. claims: 1-45 (all partially)

Methods of identifying a soybean plant or germplasm that displays tolerance, improved tolerance or susceptibility to iron deficiency comprising detecting in said soybean at least one allele of one or more of the marker locus P5219A-1, P7659A-2, SATT570, SATT_117, SATT191 and S60143-TB (linkage group G), introgressed soybean plants or germplasms identified by said methods. Methods of producing a soybean plant having tolerance or improved tolerance to low iron growth conditions comprising introducing an exogenous nucleic acid into a target soybean plant or progeny thereof, wherein said nucleic acid sequence is linked to at least one favorable allele of P5219A-1, P7659A-2, SATT570, SATT_117, SATT191 and S60143-TB. Systems for identifying a soybean plant predicted to have tolerance, improved tolerance or susceptibility to low iron growth conditions, the system comprising a set of marker probes or primers configured to detect at least one favorable allele of one marker locus selected from P5219A-1, P7659A-2, SATT570, SATT_117, SATT191 and S60143-TB. Compositions comprising an amplification primer pair capable of initiating DNA polymerization by DNA polymerase on a soybean nucleic acid template to generate a soybean marker amplicon corresponding to S60143-TB.

5. claims: 1-43 (all partially)

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Methods of identifying a soybean plant or germplasm that displays tolerance, improved tolerance or susceptibility to iron deficiency comprising detecting in said soybean at least one allele of one or more of the marker locus SATT451 and SATT367 (linkage group I), introgressed soybean plants or germplasms identified by said methods. Methods of producing a soybean plant having tolerance or improved tolerance to low iron growth conditions comprising introducing an exogenous nucleic acid into a target soybean plant or progeny thereof, wherein said nucleic acid sequence is linked to at least one favorable allele of SATT451 and SATT367.

Systems for identifying a soybean plant predicted to have tolerance, improved tolerance or susceptibility to low iron growth conditions, the system comprising a set of marker probes or primers configured to detect at least one favorable allele of one marker locus selected from SATT451 and SATT 367.

6. claims: 1-45 (all partially)

Methods of identifying a soybean plant or germplasm that displays tolerance, improved tolerance or susceptibility to iron deficiency comprising detecting in said soybean at least one allele of one or more of the marker locus SATT495, P10649C-3, SATT 613, S60392-TB (linkage group L), introgressed soybean plants or germplasms identified by said methods. Methods of producing a soybean plant having tolerance or improved tolerance to low iron growth conditions comprising introducing an exogenous nucleic acid into a target soybean plant or progeny thereof, wherein said nucleic acid sequence is linked to at least one favorable allele of SATT495, P10649C-3, SATT 613 and S60392-TB.

Systems for identifying a soybean plant predicted to have tolerance, improved tolerance or susceptibility to low iron growth conditions, the system comprising a set of marker probes or primers configured to detect at least one favorable allele of one marker locus selected from SATT 495, P10649C-3, SATT613 and S60392-TB.

Compositions comprising an amplification primer pair capable of initiating DNA polymerization by DNA polymerase on a soybean nucleic acid template to generate a soybean marker amplicon corresponding to S60392-TB.

7. claims: 1-43 (all partially)

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Methods of identifying a soybean plant or germplasm that displays tolerance, improved tolerance or susceptibility to iron deficiency comprising detecting in said soybean at least one allele of one or more of the marker locus SATT234 and SATT257 (linkage group N), introgressed soybean plants or germplasms identified by said methods. Methods of producing a soybean plant having tolerance or improved tolerance to low iron growth conditions comprising introducing an exogenous nucleic acid into a target soybean plant or progeny thereof, wherein said nucleic acid sequence is linked to at least one favorable allele of SATT234 and SATT257.

Systems for identifying a soybean plant predicted to have tolerance, improved tolerance or susceptibility to low iron growth conditions, the system comprising a set of marker probes or primers configured to detect at least one favorable allele of one marker locus selected from SATT234 and SATT257.

8. claims: 1-43 (all partially)

Methods of identifying a soybean plant or germplasm that displays tolerance, improved tolerance or susceptibility to iron deficiency comprising detecting in said soybean at least one allele of the marker locus SATT153 (linkage group O), introgressed soybean plants or germplasms identified by said methods. Methods of producing a soybean plant having tolerance or improved tolerance to low iron growth conditions comprising introducing an exogenous nucleic acid into a target soybean plant or progeny thereof, wherein said nucleic acid sequence is linked to at least one favorable allele of SATT153.

Systems for identifying a soybean plant predicted to have tolerance, improved tolerance or susceptibility to low iron growth conditions, the system comprising a set of marker probes or primers configured to detect at least one favorable allele of the marker locus SATT153.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2005/028227

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6326529	B1	04-12-2001	NONE
US 6284950	B1	04-09-2001	NONE
US 6235976	B1	22-05-2001	NONE
US 6166296	A	26-12-2000	NONE
US 5917130	A	29-06-1999	NONE
US 5767349	A	16-06-1998	NONE