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PROVISIONAL APPLICATION FOR PATENT COVER SHEET – Page 1 of 2

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. ______________________

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Additional inventors are being named on the 1 *separately numbered sheets attached hereto.*

TITLE OF THE INVENTION (500 characters max):

HERBICIDE-TOLERANT PLANTS

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

[X] The address corresponding to Customer Number: 26158

OR

[ ] Firm or Individual Name

Address

City	State	Zip
Country	Telephone	Email

ENCLOSED APPLICATION PARTS (*check all that apply*)

[ ] Application Data Sheet. See 37 CFR 1.76

[ ] CD(s), Number of CDs ______

[X] Drawing(s) *Number of Sheets* 48

[ ] Other (specify) ______

[X] Specification (e.g. description of the invention) *Number of Pages* 217

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SIGNATURE ______________________ Date September 1, 2009

TYPED or PRINTED NAME Lawrence J. Carroll REGISTRATION NO. 40,940
(if appropriate)

TELEPHONE (202) 467-6900 Docket Number: B248 1010.P1

SUPPLEMENTAL SHEET TO
PROVISIONAL APPLICATION COVER SHEET (PTO/SB/16)
(Page 1 of 1)

First Named Inventor	Scots L. Mankin	Docket Number	B248 1010.P1

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WCSR 4196862v1

HERBICIDE-TOLERANT PLANTS

BACKGROUND OF THE INVENTION

[0001] Rice is one of the most important food crops in the world, particularly in Asia. Rice is a cereal grain produced by plants in the genus *Oryza*. The two most frequently cultivated species are *Oryza sativa* and *Oryza glaberrima*, with *O. sativa* being the most frequently cultivated domestic rice. In addition to the two domestic species, the genus *Oryza* contains more than 20 wild species. One of these wild species, *Oryza rufipogon* ("red rice" also referred to as *Oryza sativa* subsp. *rufipogon*) presents a major problem in commercial cultivation. Red rice produces red coated seeds. After harvest, rice seeds are milled to remove their hull. After milling, domestic rice is white while wild red rice appears discolored. The presence of discolored seeds reduces the value of the rice crop. Since red rice belongs to the same species as cultivated rice (*Oryza sativa*), their genetic makeup is very similar. This genetic similarity has made herbicidal control of red rice difficult.

[0002] Domestic rice tolerant to imidazolinone herbicides have been developed and are currently marketed under the tradename CLEARFIELD®. Imidazolinone herbicides inhibit a plant's acetohydroxyacid synthase (AHAS) enzyme. When cultivating CLEARFIELD® rice, it is possible to control red rice and other weeds by application of imidazolinone herbicides. Unfortunately, imidazolinone herbicide-tolerant red rice and weeds have developed.

[0003] Acetyl-Coenzyme A carboxylase (acetyl-Coenzyme A carboxylase; EC 6.4.1.2) enzymes synthesize malonyl-CoA as the start of the de novo fatty acid synthesis pathway in plant chloroplasts. ACCase in grass chloroplasts is a multifunctional, nuclear-genome-encoded, very large, single polypeptide, transported into the plastid via an N-terminal transit peptide. The active form in grass chloroplasts is a homomeric protein, likely a homodimer.

[0004] ACCase enzymes in grasses are inhibited by three classes of herbicidal active ingredients. The two most prevalent classes are aryloxyphenoxypropanoates ("FOPs") and cyclohexanediones ("DIMs"). In addition to these two classes, a third class phenylpyrazolines ("DENs") has been described.

[0005] A number of ACCase-inhibitor-tolerance (AIT) mutations have been found in monocot weed species exhibiting tolerance toward one or more DIM or FOP herbicides. Further, an AIT maize has been marketed by BASF. All such mutations are found in the carboxyltransferase domain of the ACCase enzyme, and these appear to be located in a substrate binding pocket, altering access to the catalytic site.

[0006] DIMs and FOPs are important herbicides and it would be advantageous if rice could be provided that exhibits tolerance to these classes of herbicide. Currently, these classes of herbicide are of limited value in rice agriculture. In some cases, herbicide-tolerance-inducing mutations create a severe fitness penalty in the tolerant plant. Therefore, there remains a need in the art for an AIT rice that also exhibits no fitness penalty. This need and others are met by the present invention.

BRIEF SUMMARY OF THE INVENTION

[0007] The present invention relates to herbicide-tolerant plants and methods of producing and treating herbicide-tolerant plants. In one embodiment, the present invention provides a rice plant tolerant to at least one herbicide that inhibits acetyl-Coenzyme A carboxylase activity at levels of herbicide that would normally inhibit the growth of a rice plant. Typically, an herbicide-tolerant rice plant of the invention expresses an acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid sequence differs from an amino acid sequence of an acetyl-Coenzyme A carboxylase of a wild-type rice plant. By convention, mutations within monocot ACCase amino acid residues are typically referred to in reference to their position in the *Alopecurus myosuroides* (blackgrass) ACCase sequence (Genbank CAC84161.1) and denoted with an (*Am*). Examples of amino acid positions at which an acetyl-Coenzyme A carboxylase of a herbicide-tolerant plant of the invention differs from the acetyl-Coenzyme A carboxylase of the corresponding wild-type plant include, but are not limited to, one or more of the following positions: 1,781(*Am*), 1,999(*Am*), 2,027(*Am*), 2,041(*Am*), 2,078(*Am*), 2088(*Am*) or 2,096(*Am*). Examples of differences at these amino acid positions include, but are not limited to, one or more of the following: the amino acid at position 1,781(*Am*) is other than isoleucine; the amino acid at position 1,999(*Am*) is other than tryptophan; the amino acid at position 2,027(*Am*) is other than tryptophan; the amino acid at position 2,041(*Am*) is other than isoleucine; the amino acid at position 2,078(*Am*) is other than aspartate; the amino acid at position 2088(*Am*) is other than cysteine; or the amino acid at position 2,096(*Am*) is other than glycine. In some embodiments, the present invention provides a rice plant expressing an acetyl-Coenzyme A carboxylase enzyme comprising an amino acid sequence that comprises one or more of the following: the amino acid at position 1,781(*Am*) is leucine or alanine; the amino acid at position 1,999(*Am*) is cysteine; the amino acid at position 2,027(*Am*) is cysteine; the amino acid at position 2,041(*Am*) is asparagine; the amino acid at position 2,078(*Am*) is glycine; the amino acid at position 2088(*Am*) is arginine or the amino acid at position 2,096(*Am*) is alanine.

[0008] The present invention also provides methods of producing herbicide-tolerant plants and plants produced by such methods. An example of a plant produced by the methods of the invention is an herbicide-tolerant rice plant which is tolerant to at least one herbicide that inhibits acetyl-Coenzyme A carboxylase activity at levels of herbicide that would normally inhibit the growth of said plant, wherein the herbicide-tolerant plant is produced by: a) obtaining cells from a plant that is not tolerant to the herbicide; b) contacting the cells with a medium comprising one or more acetyl-Coenzyme A carboxylase inhibitors; and c) generating an herbicide-tolerant plant from the cells. Herbicide-tolerant plants produced by methods of the invention include, but are not limited to, herbicide-tolerant plants generated by performing a), b) and c) above and progeny of a plant generated by performing a), b), and c) above. In one embodiment, cells used to practice methods of this type will be in the form of a callus.

[0009] The present invention provides plants expressing acetyl-Coenzyme A carboxylase enzymes comprising defined amino acid sequences. For example, the present invention provides a rice plant, wherein one or more of the genomes of said rice plant encode a protein comprising a modified version of one or both of SEQ ID NOs: 2 and 3, wherein the sequence is modified such that the encoded protein comprises one or more of the following: the amino acid at position 1,781(*Am*) is leucine or alanine; the amino acid at position 1,999(*Am*) is cysteine; the amino acid at position 2,027(*Am*) is cysteine; the amino acid at position 2,041(*Am*) is asparagine; the amino acid at position 2,078(*Am*) is glycine; the amino acid at position 2088(*Am*) is arginine or the amino acid at position 2,096(*Am*) is alanine. Table 3 below provides an alignment of the *Alopecurus myosuroides* acetyl-Coenzyme A carboxylase sequence (SEQ ID NO:1), the *Oryza sativa* Indica1 acetyl-Coenzyme A carboxylase sequence (SEQ ID NO:2) and the *Oryza sativa* Japonica acetyl-Coenzyme A carboxylase sequence (SEQ ID NO:3) with examples of positions where the wild type sequences may differ with sequences of the invention indicated.

[0010] In another embodiment, the present invention comprises seeds deposited in an acceptable depository in accordance with the Budapest Treaty, cells derived from such seeds, plants grown from such seeds and cells derived from such plants, progeny of plants grown from such seed and cells derived from such progeny. The growth of plants produced from deposited seed and progeny of such plants will typically be tolerant to acetyl-Coenzyme A carboxylase-inhibiting herbicides at levels of herbicide that would normally inhibit the growth of a corresponding wild-type plant. In one embodiment, the present invention provides a rice plant grown from a seed having ATCC accession number PTA-10267. The present invention also encompasses mutants, recombinants, and/or genetically engineered derivatives of the plant grown from a seed having ATCC accession number PTA-10267 as well as any progeny of the plant grown from a seed having ATCC accession number PTA-10267 so long as such plants or progeny have the herbicide tolerance characteristics of the plant grown from a seed having ATCC accession number PTA-10267. The present invention also encompasses cells cultured from such seeds and plants and their progeny produced from the cultured cells.

[0011] An herbicide-tolerant plant of the invention may be a member of the species *O. sativa*. Herbicide-tolerant plants of the invention are typically tolerant to aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof at levels of herbicide that would normally inhibit the growth of a corresponding wild-type plant, for example, a rice plant. In some embodiments, an herbicide-tolerant plant of the invention is not a GMO-plant. The present invention also provides an herbicide-tolerant plant that is mutagenized, for example, a mutagenized rice plant. The present invention also encompasses cells derived from the plants and seeds of the herbicide-tolerant plants described above.

[0012] The present invention provides methods for controlling growth of weeds. In one embodiment, the present invention provides a method of controlling growth of weeds in vicinity to rice plants. Such methods may comprise applying to the weeds and rice plants an amount of an acetyl-Coenzyme A carboxylase-inhibiting herbicide that inhibits naturally occurring acetyl-Coenzyme A carboxylase activity, wherein said rice plants comprise altered acetyl-Coenzyme A carboxylase activity such that said rice plants are tolerant to the applied amount of herbicide. Methods of the invention may be practiced with any herbicide that interferes with acetyl-Coenzyme A carboxylase activity including, but not limited to, aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof.

[0013] The present invention provides a method for controlling growth of weeds in vicinity to rice plants. One example of such methods may comprise applying one or more herbicides to the weeds and to the rice plants at levels of herbicide that would normally inhibit the growth of a rice plant, wherein at least one herbicide inhibits acetyl-Coenzyme A carboxylase activity. Such methods may be practiced with any herbicide that inhibits acetyl-Coenzyme A carboxylase activity. Suitable examples of herbicides that may be used in the practice of methods of controlling weeds include, but are not limited to, aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof.

[0014] The present invention encompasses a method for controlling growth of weeds. One example of such methods may comprise (a) crossing an herbicide-tolerant rice plant with other rice germplasm, and harvesting the resulting hybrid rice seed; (b) planting the hybrid rice seed; and (c) applying one or more acetyl-Coenzyme A carboxylase-inhibiting herbicides to the hybrid rice and to the weeds in vicinity to the hybrid rice at levels of herbicide that would normally inhibit the growth of a rice plant. Such methods may be practiced with any herbicide that inhibits acetyl-Coenzyme A carboxylase activity. Suitable examples of herbicides that may be used in the practice of methods of controlling weeds include, but are not limited to, aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof.

[0015] In another embodiment, the present invention includes a method for selecting herbicide-tolerant rice plants. One example of such methods may comprise (a) crossing an herbicide-tolerant rice plant with other rice germplasm, and harvesting the resulting hybrid rice seed; (b) planting the hybrid rice seed; (c) applying one or more herbicides to the hybrid rice at levels of herbicide that would normally inhibit the growth of a rice plant, wherein at least one of the herbicides inhibits acetyl-Coenzyme A carboxylase; and (d) harvesting seeds from the rice plants to which herbicide has been applied. Such methods may be practiced with any herbicide that inhibits acetyl-Coenzyme A carboxylase activity. Suitable examples of herbicides that may be used in the practice of methods of controlling weeds include, but are not limited to, aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof.

[0016] The present invention also encompasses a method for growing herbicide-tolerant rice plants. One example of such a method comprises (a) planting rice seeds; (b) allowing the rice seeds to sprout; (c) applying one or more herbicides to the rice sprouts at levels of herbicide that would normally inhibit the growth of a rice plant, wherein at least one of the herbicides inhibits acetyl-Coenzyme A carboxylase. Such methods may be practiced with any herbicide that inhibits acetyl-Coenzyme A carboxylase activity. Suitable examples of herbicides that may be used in the practice of methods of controlling weeds include, but are not limited to, aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof.

[0017] In one embodiment, the present invention provides a seed of an herbicide-tolerant rice plant. Such seed may be used to grow herbicide-tolerant rice plants, wherein a plant grown from the seed is tolerant to at least one herbicide that inhibits acetyl-Coenzyme A carboxylase activity at levels of herbicide that would normally inhibit the growth of a rice plant. Examples of herbicides to which plants grown from seeds of the invention would be tolerant include but are not limited to, aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof.

[0018] In another embodiment, the present invention provides a seed of a rice plant, wherein a plant grown from the seed expresses an acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid sequence differs from an amino acid sequence of an acetyl-

Coenzyme A carboxylase of a wild-type rice plant at one or more of the following positions: 1,781(*Am*), 1,999(*Am*), 2,027(*Am*), 2,041(*Am*), 2,078(*Am*), 2088(*Am*) or 2,096(*Am*). Examples of differences at these amino acid positions include, but are not limited to, one or more of the following: the amino acid at position 1,781(*Am*) is other than isoleucine; the amino acid at position 1,999(*Am*) is other than tryptophan; the amino acid at position 2,027(*Am*) is other than tryptophan; the amino acid at position 2,041(*Am*) is other than isoleucine; the amino acid at position 2,078(*Am*) is other than aspartate; the amino acid at position 2088(*Am*) is other than cysteine; or the amino acid at position 2,096(*Am*) is other than glycine. In some embodiments, a plant grown from a seed of the invention may expresses an acetyl-Coenzyme A carboxylase enzyme comprising an amino acid sequence that comprises one or more of the following: the amino acid at position 1,781(*Am*) is leucine or alanine; the amino acid at position 1,999(*Am*) is cysteine; the amino acid at position 2,027(*Am*) is cysteine; the amino acid at position 2,041(*Am*) is asparagine; the amino acid at position 2,078(*Am*) is glycine; the amino acid at position 2088(*Am*) is arginine or the amino acid at position 2,096(*Am*) is alanine.

[0019] The present invention encompasses seeds of specific cultivars. One example of such seeds is a seed of rice cultivar Indica1, wherein a representative sample of seed of said cultivar was deposited under ATCC Accession No. PTA-10267. The present invention also encompasses a rice plant, or a part thereof, produced by growing the seeds as well as a tissue culture of cells produced from the seed. Tissue cultures of cells may be produced from a seed directly or from a part of a plant grown from a seed, for example, from the leaves, pollen, embryos, cotyledons, hypocotyls, meristematic cells, roots, root tips, pistils, anthers, flowers and/or stems. The present invention also includes plants and their progeny that have been generated from tissue cultures of cells. Such plants will typically have all the morphological and physiological characteristics of cultivar Indica1.

[0020] The present invention also provides methods for producing rice seed. Such methods may comprise crossing an herbicide-tolerant rice plant with other rice germplasm; and harvesting the resulting hybrid rice seed, wherein the herbicide-tolerant rice plant is tolerant to aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof at levels of herbicide that would normally inhibit the growth of a rice plant.

[0021] The present method also comprises methods of producing F1 hybrid rice seed. Such methods may comprise crossing an herbicide-tolerant rice plant with a different rice plant; and harvesting the resultant F1 hybrid rice seed, wherein the herbicide-tolerant rice plant is tolerant to aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof at levels of herbicide that would normally inhibit the growth of a rice plant.

[0022] The present invention also provides methods of producing herbicide-tolerant rice plants that may also comprise a transgene. One example of such a method may comprise transforming a cell of a rice plant with a transgene, wherein the transgene encodes an acetyl-Coenzyme A carboxylase enzyme that confers tolerance to at least one herbicide is selected from the group consisting of aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof. Any suitable cell may be used in the practice of the methods of the invention, for example, the cell may be in the form of a callus. In some embodiments, the transgene may comprise a nucleic acid sequence encoding an amino acid sequence comprising a modified version of one or both of SEQ ID NOs: 2 and 3, wherein the sequence is modified such that the encoded protein comprises one or more of the following: the amino acid at position 1,781(*Am*) is leucine or alanine; the amino acid at position 1,999(*Am*) is cysteine; the amino acid at position 2,027(*Am*) is cysteine; the amino acid at position 2,041(*Am*) is asparagine; the amino acid at position 2,078(*Am*) is glycine; the amino acid at position 2088(*Am*) is arginine or the amino acid at position 2,096(*Am*) is alanine. The present invention also encompasses plants produced by such methods. Another example of a method of producing an herbicide-tolerant plant comprising a transgene may comprise transforming a cell of a rice plant with a transgene encoding an enzyme that confers herbicide tolerance, wherein the cell was produced from a rice plant or seed thereof expressing an acetyl-Coenzyme A carboxylase enzyme that confers tolerance to at least one herbicide is selected from the group consisting of aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof. Any suitable cell may be used in the practice of the methods of the invention, for example, the cell may be in the form of a callus. The present invention also encompasses herbicide-tolerant plants produced by such methods.

[0023] In one embodiment, the present invention comprises methods of producing recombinant plants. An example of a method for producing a recombinant rice plant may comprise transforming a cell of a rice plant with a transgene, wherein the cell was produced from a rice plant expressing an acetyl-Coenzyme A carboxylase enzyme that confers tolerance to at least one herbicide is selected from the group consisting of aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof. Any suitable cell may be used in the practice of the methods of the invention, for example, the cell may be in the form of a callus. A transgene for use in the methods of the invention may comprise any desired nucleic acid sequence, for example, the transgene may encode a protein. In one example, the transgene may encode an enzyme, for example, an enzyme that modifies fatty acid metabolism and/or carbohydrate metabolism. Examples of suitable enzymes include but are not limited to, fructosyltransferase, levansucrase, alpha-amylase, invertase and starch branching enzyme or encoding an antisense of stearyl-ACP desaturase. The present invention also encompasses recombinant plants produced by methods of the invention.

[0024] Methods of the invention may be used to produce a plant, e.g., a rice plant, having any desired traits. An example of such a method may comprise: (a) crossing a rice plant that is tolerant to aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof at levels of herbicide that would normally inhibit the growth of a rice plant with a plant of another rice cultivar that comprises the desired trait to produce progeny plants; (b) selecting one or more progeny plants that have the desired trait to produce selected progeny plants; (c) crossing the selected progeny plants with the herbicide-tolerant plants to produce backcross progeny plants; (d) selecting for backcross progeny plants that have the desired trait and herbicide tolerance; and (e) repeating steps (c) and (d) three or more times in succession to produce selected fourth or higher backcross progeny plants that comprise the desired trait and herbicide tolerance. Any desired trait may be introduced using the methods of the invention. Examples of traits that may be desired include, but are not limited to, male sterility, herbicide tolerance, drought tolerance insect resistance, modified fatty acid metabolism, modified carbohydrate metabolism and resistance to bacterial disease, fungal disease or viral disease. An example of a method for producing a male sterile rice plant may comprise transforming a rice plant tolerant to at least one herbicide that inhibits acetyl-Coenzyme A carboxylase activity at levels of herbicide that would normally inhibit the growth of a rice plant with a nucleic acid molecule that confers male sterility. The present invention also encompasses male sterile plants produced by such methods.

[0025] The present invention provides compositions comprising plant cells, for example, cells from a rice plant. One example of such a composition comprises one or more cells of a rice plant; and an aqueous medium, wherein the medium comprises a compound that inhibits acetyl-Coenzyme A carboxylase activity. In some embodiments, the cells may be derived from a rice plant tolerant to aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof at levels of herbicide that would normally inhibit the growth of a rice plant. Any compound that inhibits acetyl-Coenzyme A carboxylase activity may be used in the compositions of the invention, for example, one or more of aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides and combinations thereof.

[0026] The present invention comprises nucleic acid molecules encoding all or a portion of an acetyl-Coenzyme A carboxylase enzyme. In some embodiments, the invention comprises a recombinant, mutagenized, synthetic, and/or isolated nucleic acid molecule encoding a rice acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid sequence differs from an amino acid sequence of an acetyl-Coenzyme A carboxylase of a wild-type rice plant at one or more of the following positions: 1,781(*Am*), 1,999(*Am*), 2,027(*Am*), 2,041(*Am*), 2,078(*Am*), 2088(*Am*) or 2,096(*Am*). Examples of differences at these amino acid positions include, but are not limited to, one or more of the following: the amino acid at position 1,781(*Am*) is other than isoleucine; the amino acid at position 1,999(*Am*) is other than tryptophan; the amino acid at position 2,027(*Am*) is other than tryptophan; the amino acid at position 2,041(*Am*) is other than isoleucine; the amino acid at position 2,078(*Am*) is other than aspartate; the amino acid at position 2088(*Am*) is other than cysteine; or the amino acid at position 2,096(*Am*) is other than glycine. In some embodiments, a nucleic acid molecule of the invention may encode an acetyl-Coenzyme A carboxylase enzyme comprising an amino acid sequence that comprises one or more of the following: the amino acid at position 1,781(*Am*) is leucine or alanine; the amino acid at position 1,999(*Am*) is cysteine; the amino acid at position 2,027(*Am*) is cysteine; the amino acid at position 2,041(*Am*) is asparagine; the amino acid at position 2,078(*Am*) is glycine; the amino acid at position 2088(*Am*) is arginine or the amino acid at position 2,096(*Am*) is alanine. In some embodiments, the invention comprises a recombinant, mutagenized, synthetic, and/or isolated encoding a protein comprising all or a portion of a modified version of one or both of SEQ ID NOs: 2 and 3, wherein the sequence is modified such that the encoded protein comprises one or more of the following: the amino acid at position 1,781(*Am*) is leucine or alanine; the amino acid at position 1,999(*Am*) is cysteine; the amino acid at position 2,027(*Am*) is cysteine; the amino acid at position 2,041(*Am*) is asparagine; the amino acid at position 2,078(*Am*) is glycine; the amino acid at position 2088(*Am*) is arginine or the amino acid at position 2,096(*Am*) is alanine.

[0027] In one embodiment, the present invention provides an herbicide-tolerant, BEP clade plant. Typically such a plant is one having increased tolerance to an ACCase-inhibitor (ACCI) as compared to a wild-type variety of the plant. Such plants may be produced by a process comprising either:

(I) the steps of

(a) providing BEP clade plant cells having a first, zero or non-zero level of ACCI tolerance;

(b) growing the cells in contact with a medium to form a cell culture;

(c) contacting cells of said culture with an ACCI;

(d) growing ACCI-contacted cells from step (c) to form a culture containing cells having a level of ACCI tolerance greater than the first level of step (a); and

(e) generating, from ACCI-tolerant cells of step (d), a plant having a level of ACCI tolerance greater than that of a wild-type variety of the plant; or

(II) the steps of

(f) providing a first, herbicide-tolerant, BEP clade plant having increased tolerance to an ACCase-inhibitor (ACCI) as compared to a wild-type variety of the plant, said herbicide-tolerant plant having been produced by a process comprising steps (a)-(e); and

(g) producing from the first plant a second, herbicide-tolerant, BEP clade plant that retains the increased herbicide tolerance characteristics of the first plant;

thereby obtaining an herbicide-tolerant, BEP clade plant. In some embodiments, an herbicide-tolerant plant of the invention may be a member of the Bambusoideae - Ehrhartoideae subclade. Any suitable medium for growing plant cells may be used in the practice of the invention. In some embodiments, the medium may comprise a mutagen while in other embodiments the medium does not comprise a mutagen. In some embodiments, an herbicide-tolerant plant of the invention may be a member of the subfamily Ehrhartoideae. Any suitable cells may be used in the practice of the methods of the invention, for example, the cells may be in the form of a callus. In some embodiments, an herbicide-tolerant plant of the invention may be a member of the genus *Oryza*, for example, may be a member of the species *O. sativa*.

[0028] The present invention includes herbicide-tolerant BEP clade plants produced by the above method. Such herbicide-tolerant plants may express an acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid sequence differs from an amino acid sequence of an acetyl-Coenzyme A carboxylase of a corresponding wild-type BEP clade plant at one or more of the following positions: 1,781(*Am*), 1,999(*Am*), 2,027(*Am*), 2,041(*Am*), 2,078(*Am*), 2088(*Am*) or 2,096(*Am*). Examples of differences at these amino acid positions include, but are not limited to, one or more of the following: the amino acid at position 1,781(*Am*) is other than isoleucine; the amino acid at position 1,999(*Am*) is other than tryptophan; the amino acid at position 2,027(*Am*) is other than tryptophan; the amino acid at position 2,041(*Am*) is other than isoleucine; the amino acid at position 2,078(*Am*) is other than aspartate; the amino acid at position 2088(*Am*) is other than cysteine; or the amino acid at position 2,096(*Am*) is other than glycine. In some embodiments, an herbicide-tolerant BEP clade plant of the invention may expresses an acetyl-Coenzyme A carboxylase enzyme comprising an amino acid sequence that comprises one or more of the following: the amino acid at position 1,781(*Am*) is leucine or alanine; the amino acid at position 1,999(*Am*) is cysteine; the amino acid at position 2,027(*Am*) is cysteine; the amino acid at position 2,041(*Am*) is asparagine; the amino acid at position 2,078(*Am*) is glycine; the amino acid at position 2088(Am) is arginine or the amino acid at position 2,096(*Am*) is alanine.

[0029] The present invention also encompasses herbicide-tolerant BEP clade plants produced by the process of (a) crossing or back-crossing a plant grown from a seed of an herbicide-tolerant BEP clade plant produced as described above with other germplasm; (b) growing the plants resulting from said crossing or back-crossing in the presence of at least one herbicide that normally inhibits acetyl-Coenzyme A carboxylase, at levels of the herbicide that would normally inhibit the growth of a plant; and (c) selecting for further propagation plants resulting from said crossing or back-crossing, wherein the plants selected are plants that grow without significant injury in the presence of the herbicide.

[0030] The present invention also encompasses a recombinant, mutagenized, synthetic, and/or isolated nucleic acid molecule comprising a nucleotide sequence encoding a mutagenized acetyl-Coenzyme A carboxylase of a plant in the BEP clade of the Family Poaceae, in which the amino acid sequence of the mutagenized acetyl-Coenzyme A carboxylase differs from an amino acid sequence of an acetyl-Coenzyme A carboxylase of the corresponding wild-type plant at one or more of the following positions: 1,781(*Am*), 1,999(*Am*), 2,027(*Am*), 2,041(*Am*), 2,078(*Am*), 2088(*Am*) or 2,096(*Am*). Such a nucleic acid molecule may b produced by a process comprising either:

(I) the steps of

(a) providing BEP clade plant cells having a first, zero or non-zero level of ACCase-inhibitor (ACCI) tolerance;

(b) growing the cells in contact with a medium to form a cell culture;

(c) contacting cells of said culture with an ACCI;

(d) growing ACCI-contacted cells from step (c) to form a culture containing cells having a level of ACCI tolerance greater than the first level of step (a); and

(e) generating, from ACCI-tolerant cells of step (d), a plant having a level of ACCI tolerance greater than that of a wild-type variety of the plant; or

(II) the steps of

(f) providing a first, herbicide-tolerant, BEP clade plant having increased tolerance to an ACCase-inhibitor (ACCI) as compared to a wild-type variety of the plant, said herbicide-tolerant plant having been produced by a process comprising steps (a)-(e); and

(g) producing from the first plant a second, herbicide-tolerant, BEP clade plant that retains the increased herbicide tolerance characteristics of the first plant;

thereby obtaining an herbicide-tolerant, BEP clade plant; and isolating a nucleic acid from the herbicide-tolerant BEP clade plant.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] Figure 1 is a bar graph showing relative growth rice calli derived from *Oryza sativa* subsp. *indica* grown in the presence of difference selection levels of herbicide. Figure 1A shows the results obtained with tepraloxydim, Figure 1B shows the results obtained with sethoxydim, and Figure 1C shows the results obtained with cycloxydim.

[0032] Figure 2 is a diagram of the selection process used to produce herbicide-tolerant rice plants.

[0033] Figure 3 shows photographs of plants taken one week after treatment with herbicide.

[0034] Figure 4 shows photographs of plants taken two weeks after treatment with herbicide.

[0035] Figure 5 provides the GenBank record for acetyl-coenzyme A carboxylase from *Alopecurus myosuroides* accession number CAC84161.

[0036] Figure 6 provides the GenBank record for the mRNA encoding acetyl-coenzyme A carboxylase from *Alopecurus myosuroides* accession number AJ310767 region: 157..7119.

[0037] Figure 7A provides the nucleotide sequence encoding *Oryza sativa* Indica acetyl-Coenzyme A carboxylase (SEQ ID NO:5).

[0038] Figure 7B provides the amino acid sequence of *Oryza sativa* Indica acetyl-Coenzyme A carboxylase (SEQ ID NO:3).

[0039] Figure 8A provides the nucleotide sequence encoding *Oryza sativa* Japonica acetyl-Coenzyme A carboxylase (SEQ ID NO:6).

[0040] Figure 8B provides the amino acid sequence of *Oryza sativa* Japonica acetyl-Coenzyme A carboxylase (SEQ ID NO:3).

[0041] Figure 9A provides the nucleotide sequence encoding *Zea mays* acetyl-Coenzyme A carboxylase (SEQ ID NO:11).

[0042] Figure 9B provides the amino acid sequence of *Zea mays* acetyl-Coenzyme A carboxylase (SEQ ID NO:12).

[0043] Figure 10A provides the nucleotide sequence encoding *Zea mays* acetyl-Coenzyme A carboxylase (SEQ ID NO:13).

[0044] Figure 10B provides the amino acid sequence of *Zea mays* acetyl-Coenzyme A carboxylase (SEQ ID NO:14).

[0045] Figure 11A provides the nucleotide sequence encoding *Triticum aestivum* acetyl-Coenzyme A carboxylase (SEQ ID NO:15).

[0046] Figure 11B provides the amino acid sequence of *Triticum aestivum* acetyl-Coenzyme A carboxylase (SEQ ID NO:16).

[0047] Figure 12A provides the nucleotide sequence encoding *Setaria italica* acetyl-Coenzyme A carboxylase (SEQ ID NO:17).

[0048] Figure 12B provides the amino acid sequence of *Setaria italica* acetyl-Coenzyme A carboxylase (SEQ ID NO:18).

[0049] Figure 13A provides the nucleotide sequence encoding *Setaria italica* acetyl-Coenzyme A carboxylase (SEQ ID NO:19).

[0050] Figure 13B provides the amino acid sequence of *Setaria italica* acetyl-Coenzyme A carboxylase (SEQ ID NO:20).

[0051] Figure 14A provides the nucleotide sequence encoding *Setaria italica* acetyl-Coenzyme A carboxylase (SEQ ID NO:21).

[0052] Figure 14B provides the amino acid sequence of *Setaria italica* acetyl-Coenzyme A carboxylase (SEQ ID NO:22).

[0053] Figure 15A provides the nucleotide sequence encoding *Alopecurus myosuroides* acetyl-Coenzyme A carboxylase (SEQ ID NO:23).

[0054] Figure 15B provides the amino acid sequence of *Alopecurus myosuroides* acetyl-Coenzyme A carboxylase (SEQ ID NO:24).

[0055] Figure 16A provides the nucleotide sequence encoding *Aegilops tauschii* acetyl-Coenzyme A carboxylase (SEQ ID NO:).

[0056] Figure 16B provides the amino acid sequence of *Aegilops tauschii* acetyl-Coenzyme A carboxylase (SEQ ID NO:).

DETAILED DESCRIPTION OF THE INVENTION

[0057] Definitions

[0058] As used herein, "tolerant" or "herbicide-tolerant" indicates a plant or portion thereof capable of growing in the presence of an amount of herbicide that normally causes growth inhibition in a non-tolerant (e.g., a wild-type) plant or portion thereof. Levels of herbicide that normally inhibit growth of a non-tolerant plant are known and readily determined by those skilled in the art. Examples include the amounts recommended by manufacturers for application. The following table contains a list of herbicides with the maximum rate of herbicide that is typically applied. The maximum rate is an example of an amount of herbicide that would normally inhibit growth of a non-tolerant plant.

Table 1 List of Herbicides

ACCase Inhibitor	Class	Company	Example Trade Names	Red Rice Control	Maximum Rate [g ai/ha]	Use
alloxydim	DIM	BASF	Fervin, Kusagard, NP-48Na, BAS 9021H	Good	1000	POST
butroxydim	DIM	Syngenta	Falcon, ICI-A0500	Good	75	POST
clethodim	DIM	Valent	Select, Prsim, RE-45601	Good	280	POST
clodinafop-propargyl	FOP	Syngenta	Discover, Topik, CGA 184 927	Unsure	80	POST
cycloxydim	DIM	BASF	Focus, Laser, Stratos, BAS 517H	Good	448	POST
cyhalofop-butyl	FOP	Dow	Clincher, XDE 537, DEH	None	310	POST

			112			
diclofop-methyl	FOP	Bayer	Hoegrass, Hoelon, Illoxan, HOE 23408	Good	1120	POST
fenoxaprop-P-ethyl	FOP	Bayer	Super Whip, Option Super, Exel Super, HOE-46360, Aclaim, Puma S	Partial	111	POST
fluazifop-P-butyl	FOP	Syngenta	Fusilade, Fusilade 2000, Fusilade DX, ICI-A 0009, ICI-A 0005, SL-236, IH-773B, TF-1169	Good	210	POST
haloxyfop-etotyl	FOP	Dow	Gallant, DOWCO 453EE	Good	600	POST
haloxyfop-methyl	FOP	Dow	Verdict, DOWCO 453ME	Good	600	POST
haloxyfop-P-methyl	FOP	Dow	Edge, DE 535	Good	600	POST
metamifop	FOP	Dongbu	NA	None	201	POST
pinoxaden	DEN	Syngenta	Axial	Good	60	POST
profoxydim	DIM	BASF	Aura, Tetris, BAS 625H	None	212	POST
propaquizafop	FOP	Syngenta	Agil, Shogun, Ro 17-3664	Good	150	POST
quizalofop-P-ethyl	FOP	DuPont	Assure, Assure II, DPX-Y6202-3, Targa Super, NC-302	Good	112	POST
quizalofop-P-tefuryl	FOP	Uniroyal	Pantera, UBI C4874	Good	112	POST
sethoxydim	DIM	BASF	Poast, Poast Plus, NABU, Fervinal, NP-55, Sertin, BAS 562H	Partial	560	POST
tepraloxydim	DIM	BASF	BAS 620H, Aramo	Good	60	POST
tralkoxydim	DIM	Syngenta	Achieve, Splendor, ICI-A0604	Good	3400	POST

[0059] As used herein, “recombinant” refers to an organism having genetic material from different sources.

[0060] As used herein, “mutagenized” refers to an organism having an altered genetic material as compared to the genetic material of a corresponding wild-type organism, wherein the alterations in genetic material were induced and/or selected by human action. Examples of human action that can be used to produce a mutagenized organism include, but are not limited to, tissue culture of plant cells (e.g., calli) in sub-lethal concentrations of herbicides (e.g., acetyl-Coenzyme A carboxylase inhibitors such as cycloxydim or sethoxydim), treatment of plant cells with a chemical mutagen and subsequent selection with herbicides (e.g., acetyl-Coenzyme A carboxylase inhibitors such as cycloxydim or sethoxydim); or by treatment of plant cells with x-rays and subsequent selection with herbicides (e.g., acetyl-Coenzyme A carboxylase inhibitors such as cycloxydim or sethoxydim). Any method known in the art may be used to induce mutations. Methods of inducing mutations may induce mutations in random positions in the genetic material or may induce mutations in specific locations in the genetic material (i.e., may be directed mutagenesis techniques).

[0061] As used herein, a "genetically modified organism" (GMO) is an organism whose genetic characteristics have been altered by insertion of genetic material from another source organism or progeny thereof that retain the inserted genetic material. The source organism may be of a different type of organism (e.g., a GMO plant may contain bacterial genetic material) or from the same type of organism (e.g., a GMO plant may contain genetic material from another plant). As used herein, recombinant and GMO are considered synonyms and indicate the presence of genetic material from a different source whereas mutagenized indicates altered genetic material from a corresponding wild-type organism but no genetic material from another source organism.

[0062] As used herein, "wild-type" or "corresponding wild-type plant" means the typical form of an organism or its genetic material, as it normally occurs, as distinguished from mutagenized and/or recombinant forms.

[0063] Plants

[0064] The present invention provides herbicide-tolerant monocotyledonous plants of the grass family Poaceae The family Poaceae may be divided into two major clades, the clade containing the subfamilies Bambusoideae, Ehrhartoideae, and Pooideae (the BEP clade) and the clade containing the subfamilies Panicoideae, Arundinoideae, Chloridoideae, Centothecoideae, Micrairoideae, Aristidoideae, and Danthonioideae (the PACCMAD clade). The present invention relates to plants of the BEP clade, in particular plants of the subfamilies Bambusoideae and Ehrhartoideae. Plants of the invention are typically tolerant to at least one herbicide that inhibits acetyl-Coenzyme A carboxylase activity as a result of expressing an acetyl-Coenzyme A carboxylase enzyme of the invention as described below.

[0065] In one embodiment, the present invention provides herbicide-tolerant plants of the Bambusoideae subfamily. Such plants are typically tolerant to one or more herbicides that inhibit acetyl-Coenzyme A carboxylase activity. Examples of herbicide-tolerant plants of the subfamily Bambusoideae include, but are not limited to, those of the genera *Arundinaria*, *Bambusa*, *Chusquea*, *Guadua*, and *Shibataea*.

[0066] In one embodiment, the present invention provides herbicide-tolerant plants of the Ehrhartoideae subfamily. Such plants are typically tolerant to one or more herbicides that inhibit acetyl-Coenzyme A carboxylase activity. Examples of herbicide-tolerant plants of the subfamily Ehrhartoideae include, but are not limited to, those of the genera *Erharta*, *Leersia*, *Microlaena*, *Oryza*, and *Zizania*.

[0067] In one embodiment, herbicide-tolerant plants of the invention are rice plants. Two species of rice are most frequently cultivated, *Oryza sativa* and *Oryza glaberrima*. Numerous subspecies of *Oryza sativa* are commercially important including *Oryza sativa* subsp. *indica*, *Oryza sativa* subsp. *japonica*, *Oryza sativa* subsp. *javanica*, *Oryza sativa* subsp. *glutinosa* (glutinous rice), *Oryza sativa* Aromatica group (basmati), and *Oryza sativa* Floating rice group. The present invention encompasses herbicide-tolerant plants in all of the aforementioned species and subspecies.

[0068] In addition to being able to tolerate herbicides that inhibit acetyl-Coenzyme A carboxylase activity, plants of the invention may also be able to tolerate herbicides that work on other physiological processes. For example, plants of the invention may be tolerant to acetyl-Coenzyme A carboxylase inhibitors and also tolerant to other herbicides, for example, enzyme inhibitors. Examples of other enzyme inhibitors to which plants of the invention may be tolerant include, but are not limited to, inhibitors of 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) such as glyphosate, inhibitors of acetohydroxyacid synthase (AHAS) such as imidazolinone and sulfonamide herbicides, and inhibitors of glutamine synthase such as glufosinate. In addition to enzyme inhibitors, plants of the invention may also be tolerant of herbicides having other modes of action, for example, auxin growth regulators, chlorophyll/carotenoid pigment inhibitors, cell membrane destroyers, photosynthetic inhibitors, cell division inhibitors, root inhibitors, shoot inhibitors, and combinations thereof.

[0069] The present invention also encompasses progeny of the plants of the invention as well as seeds derived from the herbicide-tolerant plants of the invention and cells derived from the herbicide-tolerant plants of the invention.

[0070] Acetyl-Coenzyme A carboxylase Enzymes

[0071] The present invention provides plants expressing acetyl-Coenzyme A carboxylase enzymes with amino acid sequences that differ from the amino acid sequence of the acetyl-Coenzyme A carboxylase enzyme found in the corresponding wild-type plant. For ease of understanding, the amino acid numbering system used herein will be the numbering system used for the acetyl-Coenzyme A carboxylase from *Alopecurus myosuroides* [Huds.] (also referred to as black grass). The mRNA sequence encoding the *A. myosuroides* acetyl-Coenzyme A carboxylase is available at GenBank accession number AJ310767 and the protein sequence is available at GenBank accession no. CAC84161 both of which are specifically incorporated herein by reference. The number of the amino acid referred to will be followed with (*Am*) to indicate the amino acid in the *Alopecurus myosuroides* sequence to which the amino acid corresponds. The following table provides the amino acid sequence of *Alopecurus myosuroides* acetyl-Coenzyme A carboxylase.

[0072] Table 2 *Alopecurus myosuroides* acetyl-Coenzyme A carboxylase amino acid sequence GenBank accession no. CAC84161. Amino acids that by be altered in the acetyl-Coenzyme A carboxylase enzymes of the invention are indicted in bold double underline.

1	MGSTHLPIVG	FNASTTPSLS	TLRQINSAAA	AFQSSSPSRS	SKKKSRRVKS	IRDDGDGSVP
61	DPAGHGQSIR	QGLAGIIDLP	KEGASAPDVD	ISHGSEDHKA	SYQMNGILNE	SHNGRHASLS
121	KVYEFCTELG	GKTPIHSVLV	ANNGMAAAKF	MRSVRTWAND	TFGSEKAIQL	IAMATPEDMR
181	INAEHIRIAD	QFVEVPGGTN	NNNYANVQLI	VEIAERTGVS	AVWPGWGHAS	ENPELPDALT
241	AKGIVFLGPP	ASSMNALGDK	VGSALIAQAA	GVPTLAWSGS	HVEIPLELCL	DSIPEEMYRK
301	ACVTTADEAV	ASCQMIGYPA	MIKASWGGGG	KGIRKVNNDD	EVKALFKQVQ	GEVPGSPIFI
361	MRLASQSRHL	EVQLLCDEYG	NVAALHSRDC	SVQRRHQKII	EEGPVTVAPR	ETVKELEQAA
421	RRLAKAVGYV	GAATVEYLYS	METGEYYFLE	LNPRLQVEHP	VTESIAEVNL	PAAQVAVGMG
481	IPLWQIPEIR	RFYGMDNGGG	YDIWRKTAAL	ATPFNFDEVD	SQWPKGHCVA	VRITSENPDD
541	GFKPTGGKVK	EISFKSKPNV	WGYFSVKSGG	GIHEFADSQF	GHVFAYGETR	SAAITSMSLA
601	LKEIQIRGEI	HTNVDYTVDL	LNAPDFRENT	IHTGWLDTRI	AMRVQAERPP	WYISVVGGAL
661	YKTITTNAET	VSEYVSYLIK	GQIPPKHISL	VHSTISLNIE	ESKYTIEIVR	SGQGSYRLRL
721	NGSLIEANVQ	TLCDGGLLMQ	LDGNSHVIYA	EEEAGGTRLL	IDGKTCLLQN	DHDPSRLLAE
781	TPCKLLRFLI	ADGAHVDADV	PYAEVEVMKM	CMPLLSPAAG	VINVLLSEGQ	AMQAGDLIAR
841	LDLDDPSAVK	RAEPFEGSFP	EMSLPIAASG	QVHKRCAASL	NAARMVLAGY	DHAANKVVQD
901	LVWCLDTPAL	PFLQWEELMS	VLATRLPRRL	KSELEGKYNE	YKLNVDHVKI	KDFPTEMLRE
961	TIEENLACVS	EKEMVTIERL	VDPLMSLLKS	YEGGRESHAH	FIVKSLFEEY	LSVEELFSDG
1021	IQSDVIERLR	LQYSKDLQKV	VDIVLSHQGV	RNKTKLILAL	MEKLVYPNPA	AYRDQLIRFS
1081	SLNHKRYYKL	ALKASELLEQ	TKLSELRTSI	ARNLSALDMF	TEEKADFSLQ	DRKLAINESM
1141	GDLVTAPLPV	EDALVSLFDC	TDQTLQQRVI	QTYISRLYQP	QLVKDSIQLK	YQDSGVIALW
1201	EFTEGNHEKR	LGAMVILKSL	ESVSTAIGAA	LKDASHYASS	AGNTVHIALL	DADTQLNTTE
1261	DSGDNDQAQD	KMDKLSFVLK	QDVVMADLRA	ADVKVVSCIV	QRDGAIMPMR	RTFLLSEEKL
1321	CYEEEPILRH	VEPPLSALLE	LDKLKVKGYN	EMKYTPSRDR	QWHIYTLRNT	ENPKMLHRVF
1381	FRTLVRQPSA	GNRFTSDHIT	DVEVGHAEEP	LSFTSSSILK	SLKIAKEELE	LHAIRTGHSH
1441	MYLCILKEQK	LLDLVPVSGN	TVVDVGQDEA	TACSLLKEMA	LKIHELVGAR	MHHLSVCQWE
1501	VKLKLVSDGP	ASGSWRVVTT	NVTGHTCTVD	IYREVEDTES	QKLVYHSTAL	SSGPLHGVAL

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1561 NTSYQPLSVI DLKRCSARNN KTTYCYDFPL TFEAAVQKSW SNISSENNQC YVKATELVFA
1621 EKNGSWGTPI IPMQRAAGLN DIGMVAWILD MSTPEFPSGR QIIVIANDIT FRAGSFGPRE
1681 DAFFEAVTNL ACEKKLPLIY LAANSGARIG IADEVKSCFR VGWTDDSSPE RGFRYIYMTD
1741 EDHDRIGSSV IAHKMQLDSG EIRWVIDSVV GKEDGLGVEN IHGSAAIASA YSRAYEETFT
1801 LTFVTGRTVG IGAYLARLGI RCIQRIDQPI ILTGFSALNK LLGREVYSSH MQLGGPKIMA
1861 TNGVVHLTVP DDLEGVSNIL RWLSYVPANI GGPLPITKSL DPIDRPVAYI PENTCDPRAA
1921 ISGIDDSQGK WLGGMFDKDS FVETFEGWAK TVVTGRAKLG GIPVGVIAVE TQTMMQLVPA
1981 DPGQPDSHER SVPRAGQVWF PDSATKTAQA MLDFNREGLP LFILANWRGF SGGQRDLFEG
2041 ILQAGSTIVE NLRTYNQPAF VYIPKAAELR GGAWVVIDSK INPDRIECYA ERTAKGNVLE
2101 PQGLIEIKFR SEELKECMGR LDPELIDLKA RLQGANGSLS DGESLQKSIE ARKKQLLPLY
2161 TQIAVRFAEL HDTSLRMAAK GVIRKVVDWE DSRSFFYKRL RRRLSEDVLA KEIRGVIGEK
2221 FPHKSAIELI KKWYLASEAA AAGSTDWDDD DAFVAWRENP ENYKEYIKEL RAQRVSRLLS
2281 DVAGSSSDLQ ALPQGLSMLL DKMDPSKRAQ FIEEVMKVLK
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[0073] The amino acid sequences of wild-type *Oryza sativa* Indica (OSI) and *Oryza sativa* Japonica (OSJ) acetyl-Coenzyme A carboxylase is provided in the following table.

[0074] Table 3 Amino acid sequence of wild-type *Oryza sativa* acetyl-Coenzyme A carboxylases aligned with *Alopecurus myosuroides* acetyl-Coenzyme A carboxylase with critical residues denoted.

```
Table 2                                1                                                          60
        AmACCI [CAC84161]          (1) MGSTHLPIVGFNASTTPSLSTLRQINSAAAAFQSSSPSRSSKKKSRRVKSIRDDGDGSVP
OSIACCI [BGIOSIBCE018385]          (1) MTSTHVATLGVGAQAPPRHQ---KKSAGTAFVSSGSSRPSYRKNGQRTRSLREESNGGVS
       OsJACCI [EAZ33685]          (1) MTSTHVATLGVGAQAPPRHQ---KKSAGTAFVSSGSSRPSYRKNGQRTRSLREESNGGVS

                                       61                                                        120
        AmACCI [CAC84161]         (61) DPAGHGQSIRQGLAGIIDLPKEGASAPDVDISHGSEDHKA-----SYQMNGILNESHNGR
OSIACCI [BGIOSIBCE018385]         (58) DSKKLNHSIRQGLAGIIDLPNDAAS--EVDISHGSEDPRGPTVPGSYQMNGIINETHNGR
       OsJACCI [EAZ33685]         (58) DSKKLNHSIRQGLAGIIDLPNDAAS--EVDISHGSEDPRGPTVPGSYQMNGIINETHNGR

                                       121                                                       180
        AmACCI [CAC84161]        (116) HASLSKVYEFCTELGGKTPIHSVLVANNGMAAAKFMRSVRTWANDTFGSEKAIQLIAMAT
OSIACCI [BGIOSIBCE018385]        (116) HASVSKVVEFCTALGGKTPIHSVLVANNGMAAAKFMRSVRTWANDTFGSEKAIQLIAMAT
       OsJACCI [EAZ33685]        (116) HASVSKVVEFCTALGGKTPIHSVLVANNGMAAAKFMRSVRTWANDTFGSEKAIQLIAMAT

                                       181                                                       240
        AmACCI [CAC84161]        (176) PEDMRINAEHIRIADQFVEVPGGTNNNNYANVQLIVEIAERTGVSAVWPGWGHASENPEL
OSIACCI [BGIOSIBCE018385]        (176) PEDLRINAEHIRIADQFVEVPGGTNNNNYANVQLIVEIAERTGVSAVWPGWGHASENPEL
       OsJACCI [EAZ33685]        (176) PEDLRINAEHIRIADQFVEVPGGTNNNNYANVQLIVEIAERTGVSAVWPGWGHASENPEL

                                       241                                                       300
        AmACCI [CAC84161]        (236) PDALTAKGIVFLGPPASSMNALGDKVGSALIAQAAGVPTLAWSGSHVEIPLELCLDSIPE
OSIACCI [BGIOSIBCE018385]        (236) PDALTAKGIVFLGPPASSMHALGDKVGSALIAQAAGVPTLAWSGSHVEVPLECCLDSIPD
       OsJACCI [EAZ33685]        (236) PDALTAKGIVFLGPPASSMHALGDKVGSALIAQAAGVPTLAWSGSHVEVPLECCLDSIPD

                                       301                                                       360
        AmACCI [CAC84161]        (296) EMYRKACVTTADEAVASCQMIGYPAMIKASWGGGGKGIRKVNNDDEVKALFKQVQGEVPG
OSIACCI [BGIOSIBCE018385]        (296) EMYRKACVTTTEEAVASCQVVGYPAMIKASWGGGGKGIRKVHNDDEVRTLFKQVQGEVPG
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OsJACCI [EAZ33685]        (296) EMYRKACVTTTEEAVASCQVVGYPAMIKASWGGGGKGIRKVHNDDEVRTLFKQVQGEVPG

                                361                                                       420
AmACCI [CAC84161]         (356) SPIFIMRLASQSRHLEVQLLCDEYGNVAALHSRDCSVQRRHQKIIEEGPVTVAPRETVKE
OSIACCI [BGIOSIBCE018385] (356) SPIFIMRLAAQSRHLEVQLLCDQYGNVAALHSRDCSVQRRHQKIIEEGPVTVAPRETVKE
OsJACCI [EAZ33685]        (356) SPIFIMRLAAQSRHLEVQLLCDQYGNVAALHSRDCSVQRRHQKIIEEGPVTVAPRETVKE

                                421                                                       480
AmACCI [CAC84161]         (416) LEQAARRLAKAVGYVGAATVEYLYSMETGEYYFLELNPRLQVEHPVTESIAEVNLPAAQV
OSIACCI [BGIOSIBCE018385] (416) LEQAARRLAKAVGYVGAATVEYLYSMETGEYYFLELNPRLQVEHPVTEWIAEVNLPAAQV
OsJACCI [EAZ33685]        (416) LEQAARRLAKAVGYVGAATVEYLYSMETGEYYFLELNPRLQVEHPVTEWIAEVNLPAAQV

                                481                                                       540
AmACCI [CAC84161]         (476) AVGMGIPLWQIPEIRRFYGMDNGGGYDIWRKTAALATPFNFDEVDSQWPKGHCVAVRITS
OSIACCI [BGIOSIBCE018385] (476) AVGMGIPLWQIPEIRRFYGMNHGGGYDLWRKTAALATPFNFDEVDSKWPKGHCVAVRITS
OsJACCI [EAZ33685]        (476) AVGMGIPLWQIPEIRRFYGMNHGGGYDLWRKTAALATPFNFDEVDSKWPKGHCVAVRITS

                                541                                                       600
AmACCI [CAC84161]         (536) ENPDDGFKPTGGKVKEISFKSKPNVWGYFSVKSGGGIHEFADSQFGHVFAYGETRSAAIT
OSIACCI [BGIOSIBCE018385] (536) EDPDDGFKPTGGKVKEISFKSKPNVWAYFSVKSGGGIHEFADSQFGHVFAYGTTRSAAIT
OsJACCI [EAZ33685]        (536) EDPDDGFKPTGGKVKEISFKSKPNVWAYFSVKSGGGIHEFADSQFGHVFAYGTTRSAAIT

                                601                                                       660
AmACCI [CAC84161]         (596) SMSLALKEIQIRGEIHTNVDYTVDLLNAPDFRENTIHTGWLDTRIAMRVQAERPPWYISV
OSIACCI [BGIOSIBCE018385] (596) TMALALKEVQIRGEIHSNVDYTVDLLNASDFRENKIHTGWLDTRIAMRVQAERPPWYISV
OsJACCI [EAZ33685]        (596) TMALALKEVQIRGEIHSNVDYTVDLLNASDFRENKIHTGWLDTRIAMRVQAERPPWYISV

                                661                                                       720
AmACCI [CAC84161]         (656) VGGALYKTITTNAETVSEYVSYLIKGQIPPKHISLVHSTISLNIEESKYTIEIVRSGQGS
OSIACCI [BGIOSIBCE018385] (656) VGGALYKTVTANTATVSDYVGYLTKGQIPPKHISLVYTTVALNIDGKKYTIDTVRSGHGS
OsJACCI [EAZ33685]        (656) VGGALYKTVTANTATVSDYVGYLTKGQIPPKHISLVYTTVALNIDGKKYTIDTVRSGHGS

                                721                                                       780
AmACCI [CAC84161]         (716) YRLRLNGSLIEANVQTLCDGGLLMQLDGNSHVIYAEEEAGGTRLLIDGKTCLLQNDHDPS
OSIACCI [BGIOSIBCE018385] (716) YRLRMNGSTVDANVQILCDGGLLMQLDGNSHVIYAEEEASGTRLLIDGKTCMLQNDHDPS
OsJACCI [EAZ33685]        (716) YRLRMNGSTVDANVQILCDGGLLMQLDGNSHVIYAEEEASGTRLLIDGKTCMLQNDHDPS

                                781                                                       840
AmACCI [CAC84161]         (776) RLLAETPCKLLRFLIADGAHVDADVPYAEVEVMKMCMPLLSPAAGVINVLLSEGQAMQAG
OSIACCI [BGIOSIBCE018385] (776) KLLAETPCKLLRFLVADGAHVDADVPYAEVEVMKMCMPLLSPASGVIHVVMSEGQAMQAG
OsJACCI [EAZ33685]        (776) KLLAETPCKLLRFLVADGAHVDADVPYAEVEVMKMCMPLLSPASGVIHVVMSEGQAMQAG

                                841                                                       900
AmACCI [CAC84161]         (836) DLIARLDLDDPSAVKRAEPFEGSFPEMSLPIAASGQVHKRCAASLNAARMVLAGYDHAAN
OSIACCI [BGIOSIBCE018385] (836) DLIARLDLDDPSAVKRAEPFEDTFPQMGLPIAASGQVHKLCAASLNACRMILAGYEHDID
OsJACCI [EAZ33685]        (836) DLIARLDLDDPSAVKRAEPFEDTFPQMGLPIAASGQVHKLCAASLNACRMILAGYEHDID
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		901	960
AmACCI [CAC84161]	(896)	KVVQDLVWCLDTPALPFLQWEELMSVLATRLPRRLKSELEGKYNEYKLNVDHVKIKDFPT	
OSIACCI [BGIOSIBCE018385]	(896)	KVVPELVYCLDTPELPFLQWEELMSVLATRLPRNLKSELEGKYEEYKVKFDSGIINDFPA	
OsJACCI [EAZ33685]	(896)	KVVPELVYCLDTPELPFLQWEELMSVLATRLPRNLKSELEGKYEEYKVKFDSGIINDFPA	
		961	1020
AmACCI [CAC84161]	(956)	EMLRETIEENLACVSEKEMVTIERLVDPLMSLLKSYEGGRESHAHFIVKSLFEEYLSVEE	
OSIACCI [BGIOSIBCE018385]	(956)	NMLRVIIEENLACGSEKEKATNERLVEPLMSLLKSYEGGRESHAHFVVKSLFEEYLYVEE	
OsJACCI [EAZ33685]	(956)	NMLRVIIEENLACGSEKEKATNERLVEPLMSLLKSYEGGRESHAHFVVKSLFEEYLYVEE	
		1021	1080
AmACCI [CAC84161]	(1016)	LFSDGIQSDVIERLRLQYSKDLQKVVDIVLSHQGVRNKTKLILALMEKLVYPNPAAYRDQ	
OSIACCI [BGIOSIBCE018385]	(1016)	LFSDGIQSDVIERLRLQHSKDLQKVVDIVLSHQSVRNKTKLILKLMESLVYPNPAAYRDQ	
OsJACCI [EAZ33685]	(1016)	LFSDGIQSDVIERLRLQHSKDLQKVVDIVLSHQSVRNKTKLILKLMESLVYPNPAAYRDQ	
		1081	1140
AmACCI [CAC84161]	(1076)	LIRFSSLNHKRYYKLALKASELLEQTKLSELRTSIARNLSALDMFTEEKADFSLQDRKLA	
OSIACCI [BGIOSIBCE018385]	(1076)	LIRFSSLNHKAYYKLALKASELLEQTKLSELRARIARSLSELEMFTEESKGLSMHKREIA	
OsJACCI [EAZ33685]	(1076)	LIRFSSLNHKAYYKLALKASELLEQTKLSELRARIARSLSELEMFTEESKGLSMHKREIA	
		1141	1200
AmACCI [CAC84161]	(1136)	INESMGDLVTAPLPVEDALVSLFDCTDQTLQQRVIQTYISRLYQPQLVKDSIQLKYQDSG	
OSIACCI [BGIOSIBCE018385]	(1136)	IKESMEDLVTAPLPVEDALISLFDCSDTTVQQRVIETYIARLYQPHLVKDSIKMKWIESG	
OsJACCI [EAZ33685]	(1136)	IKESMEDLVTAPLPVEDALISLFDCSDTTVQQRVIETYIARLYQPHLVKDSIKMKWIESG	
		1201	1260
AmACCI [CAC84161]	(1196)	VIALWEFTEGNHEKR----------LGAMVILKSLESVSTAIGAALKDASHYASSAGNTV	
OSIACCI [BGIOSIBCE018385]	(1196)	VIALWEFPEGHFDARNGGAVLGDKRWGAMVIVKSLESLSMAIRFALKETSHYTSSEGNMM	
OsJACCI [EAZ33685]	(1196)	VIALWEFPEGHFDARNGGAVLGDKRWGAMVIVKSLESLSMAIRFALKETSHYTSSEGNMM	
		1261	1320
AmACCI [CAC84161]	(1246)	HIALLDADTQLNTTEDSGDNDQAQDKMDKLSFVLKQDVVMADLRAADVKVVSCIVQRDGA	
OSIACCI [BGIOSIBCE018385]	(1256)	HIALLGADNKMHIIQESG---DDADRIAKLPLILKDN--VTDLHASGVKTISFIVQRDEA	
OsJACCI [EAZ33685]	(1256)	HIALLGADNKMHIIQESG---DDADRIAKLPLILKDN--VTDLHASGVKTISFIVQRDEA	
		1321	1380
AmACCI [CAC84161]	(1306)	IMPMRRTFLLSEEKLCYEEEPILRHVEPPLSALLELDKLKVKGYNEMKYTPSRDRQWHIY	
OSIACCI [BGIOSIBCE018385]	(1311)	RMTMRRTFLWSDEKLSYEEEPILRHVEPPLSALLELDKLKVKGYNEMKYTPSRDRQWHIY	
OsJACCI [EAZ33685]	(1311)	RMTMRRTFLWSDEKLSYEEEPILRHVEPPLSALLELDKLKVKGYNEMKYTPSRDRQWHIY	
		1381	1440
AmACCI [CAC84161]	(1366)	TLRNTENPKMLHRVFFRTLVRQPSAGNRFTSDHITDVEVGHAEEPLSFTSSSILKSLKIA	
OSIACCI [BGIOSIBCE018385]	(1371)	TLRNTENPKMLHRVFFRTLVRQPSVSNKFSSGQIGDMEVGSAEEPLSFTSTSILRSLMTA	
OsJACCI [EAZ33685]	(1371)	TLRNTENPKMLHRVFFRTLVRQPSVSNKFSSGQIGDMEVGSAEEPLSFTSTSILRSLMTA	
		1441	1500
AmACCI [CAC84161]	(1426)	KEELELHAIRTGHSHMYLCILKEQKLLDLVPVSGNTVVDVGQDEATACSLLKEMALKIHE	

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OSIACCI [BGIOSIBCE018385]  (1431) IEELELHAIRTGHSHMYLHVLKEQKLLDLVPVSGNTVLDVGQDEATAYSLLKEMAMKIHE
      OsJACCI [EAZ33685]  (1431) IEELELHAIRTGHSHMYLHVLKEQKLLDLVPVSGNTVLDVGQDEATAYSLLKEMAMKIHE

                                 1501                                                    1560
      AmACCI [CAC84161]  (1486) LVGARMHHLSVCQWEVKLKLVSDGPASGSWRVVTTNVTGHTCTVDIYREVEDTESQKLVY
OSIACCI [BGIOSIBCE018385]  (1491) LVGARMHHLSVCQWEVKLKLDCDGPASGTWRIVTTNVTSHTCTVDIYREMEDKESRKLVY
      OsJACCI [EAZ33685]  (1491) LVGARMHHLSVCQWEVKLKLDCDGPASGTWRIVTTNVTSHTCTVDIYREMEDKESRKLVY

                                 1561                                                    1620
      AmACCI [CAC84161]  (1546) HSTALSSGPLHGVALNTSYQPLSVIDLKRCSARNNKTTYCYDFPLTFEAAVQKSWSNISS
OSIACCI [BGIOSIBCE018385]  (1551) HPATPAAGPLHGVALNNPYQPLSVIDLKRCSARNNRTTYCYDFPLAFETAVRKSWSSSTS
      OsJACCI [EAZ33685]  (1551) HPATPAAGPLHGVALNNPYQPLSVIDLKRCSARNNRTTYCYDFPLAFETAVRKSWSSSTS

                                 1621                                                    1680
      AmACCI [CAC84161]  (1606) ------ENNQCYVKATELVFAEKNGSWGTPIIPMQRAAGLNDIGMVAWILDMSTPEFPSG
OSIACCI [BGIOSIBCE018385]  (1611) GASKGVENAQCYVKATELVFADKHGSWGTPLVQMDRPAGLNDIGMVAWTLKMSTPEFPSG
      OsJACCI [EAZ33685]  (1611) GASKGVENAQCYVKAT-------------ELVQMDRLAGLNDIGMVAWTLKMSTPEFLSG

                                 1681                                                    1740
      AmACCI [CAC84161]  (1660) RQIIVIANDITFRAGSFGPREDAFFEAVTNLACEKKLPLIYLAANSGARIGIADEVKSCF
OSIACCI [BGIOSIBCE018385]  (1671) REIIVVANDITFRAGSFGPREDAFFEAVTNLACEKKLPLIYLAANSGARIGIADEVKSCF
      OsJACCI [EAZ33685]  (1658) REIIVVANDITFRAGSFGPREDAFFEAVTNLACEKKLPLIYLAANSGARIGIADEVKSCF

                                 1741                                                    1800
      AmACCI [CAC84161]  (1720) RVGWTDDSSPERGFRYIYMTDEDHDRIGSSVIAHKMQLDSGEIRWVIDSVVGKEDGLGVE
OSIACCI [BGIOSIBCE018385]  (1731) RVGWSDDGSPERGFQYIYLSEEDYARIGTSVIAHKMQLDSGEIRWVIDSVVGKEDGLGVE
      OsJACCI [EAZ33685]  (1718) RVGWSDDGSPERGFQYIYLSEEDYARIGTSVIAHKMQLDSGEIRWVIDSVVGKEDGLGVE

                                 1801                                                    1860
      AmACCI [CAC84161]  (1780) NIHGSAAIASAYSRAYEETFTLTFVTGRTVGIGAYLARLGIRCIQRIDQPIILTGFSALN
OSIACCI [BGIOSIBCE018385]  (1791) NIHGSAAIASAYSRAYKETFTLTFVTGRTVGIGAYLARLGIRCIQRLDQPIILTGYSALN
      OsJACCI [EAZ33685]  (1778) NIHGSAAIASAYSRAYKETFTLTFVTGRTVGIGAYLARLGIRCIQRLDQPIILTGYSALN
                                  ↑I1781(Am)L

                                 1861                                                    1920
      AmACCI [CAC84161]  (1840) KLLGREVYSSHMQLGGPKIMATNGVVHLTVPDDLEGVSNILRWLSYVPANIGGPLPITKS
OSIACCI [BGIOSIBCE018385]  (1851) KLLGREVYSSHMQLGGPKIMATNGVVHLTVSDDLEGVSNILRWLSYVPAYIGGPLPVTTP
      OsJACCI [EAZ33685]  (1838) KLLGREVYSSHMQLGGPKIMATNGVVHLTVSDDLEGVSNILRWLSYVPAYIGGPLPVTTP

                                 1921                                                    1980
      AmACCI [CAC84161]  (1900) LDPIDRPVAYIPENTCDPRAAISGIDDSQGKWLGGMFDKDSFVETFEGWAKTVVTGRAKL
OSIACCI [BGIOSIBCE018385]  (1911) LDPPDRPVAYIPENSCDPRAAIRGVDDSQGKWLGGMFDKDSFVETFEGWAKTVVTGRAKL
      OsJACCI [EAZ33685]  (1898) LDPPDRPVAYIPENSCDPRAAIRGVDDSQGKWLGGMFDKDSFVETFEGWAKTVVTGRAKL

                                 1981                                                    2040
      AmACCI [CAC84161]  (1960) GGIPVGVIAVETQTMMQLVPADPGQPDSHERSVPRAGQVWFPDSATKTAQAMLDFNREGL
OSIACCI [BGIOSIBCE018385]  (1971) GGIPVGVIAVETQTMMQTIPADPGQLDSREQSVPRAGQVWFPDSATKTAQALLDFNREGL
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      OsJACCI [EAZ33685]   (1958) GGIPVGVIAVETQTMMQTIPADPGQLDSREQSVPRAGQVWFPDSATKTAQALLDFNREGL
                                                              W1999(Am)C↑

                                  2041                                                     2100
      AmACCI [CAC84161]    (2020) PLFILANWRGFSGGQRDLFEGILQAGSTIVENLRTYNQPAFVYIPKAAELRGGAWVVIDS
OSIACCI [BGIOSIBCE018385]  (2031) PLFILANWRGFSGGQRDLFEGILQAGSTIVENLRTYNQPAFVYIPMAAELRGGAWVVVDS
      OsJACCI [EAZ33685]   (2018) PLFILANWRGFSGGQRDLFEGILQAGSTIVENLRTYNQPAFVYIPMAAELRGGAWVVVDS
                              W2027(Am)C↑   I2041(Am)N↑                         D2078(Am)G↑

                                  2101                                                     2160
      AmACCI [CAC84161]    (2080) KINPDRIECYAERTAKGNVLEPQGLIEIKFRSEELKECMGRLDPELIDLKARLQGAN-GS
OSIACCI [BGIOSIBCE018385]  (2091) KINPDRIECYAERTAKGNVLEPQGLIEIKFRSEELQDCMSRLDPTLIDLKAKLEVANKNG
      OsJACCI [EAZ33685]   (2078) KINPDRIECYAERTAKGNVLEPQGLIEIKFRSEELQDCMSRLDPTLIDLKAKLEVANKNG
                               C2088(Am)R↑       ↑G2096(Am)A

                                  2161                                                     2220
      AmACCI [CAC84161]    (2139) LSDGESLQKSIEARKKQLLPLYTQIAVRFAELHDTSLRMAAKGVIRKVVDWEDSRSFFYK
OSIACCI [BGIOSIBCE018385]  (2151) SADTKSLQENIEARTKQLMPLYTQIAIRFAELHDTSLRMAAKGVIKKVVDWEESRSFFYK
      OsJACCI [EAZ33685]   (2138) SADTKSLQENIEARTKQLMPLYTQIAIRFAELHDTSLRMAAKGVIKKVVDWEESRSFFYK

                                  2221                                                     2280
      AmACCI [CAC84161]    (2199) RLRRRLSEDVLAKEIRGVIGEKFPHKSAIELIKKWYLASEAAAAGSTDWDDDDAFVAWRE
OSIACCI [BGIOSIBCE018385]  (2211) RLRRRISEDVLAKEIRAVAGEQFSHQPAIELIKKWYSASHAA-----EWDDDDAFVAWMD
      OsJACCI [EAZ33685]   (2198) RLRRRISEDVLAKEIRAVAGEQFSHQPAIELIKKWYSASHAA-----EWDDDDAFVAWMD

                                  2281                                                     2340
      AmACCI [CAC84161]    (2259) NPENYKEYIKELRAQRVSRLLSDVAGSSSDLQALPQGLSMLLDKMDPSKRAQFIEEVMKV
OSIACCI [BGIOSIBCE018385]  (2266) NPENYKDYIQYLKAQRVSQSLSSLSDSSSDLQALPQGLSMLLDKMDPSRRAQLVEEIRKV
      OsJACCI [EAZ33685]   (2253) NPENYKDYIQYLKAQRVSQSLSSLSDSSSDLQALPQGLSMLLDKMDPSRRAQLVEEIRKV

                                  2341
      AmACCI [CAC84161]    (2319) LK
OSIACCI [BGIOSIBCE018385]  (2326) LG
      OsJACCI [EAZ33685]   (2313) LG
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[0075] In one embodiment, an acetyl-Coenzyme A carboxylase of the invention differs from the corresponding wild-type acetyl-Coenzyme A carboxylase at amino acid position 1781(*Am*). Wild-type *A. myosuroides* acetyl-Coenzyme A carboxylase has an isoleucine at position 1781(*Am*). Acetyl-Coenzyme A carboxylase enzymes of the invention will typically have an amino acid other than isoleucine at this position. Suitable examples of amino acids that may be found at this position in the acetyl-Coenzyme A carboxylase enzymes of the invention include, but are not limited to, leucine and alanine. In one embodiment, an acetyl-Coenzyme A carboxylase enzyme of the invention will have a leucine at 1781(*Am*).

[0076] In one embodiment, an acetyl-Coenzyme A carboxylase of the invention differs from the corresponding wild-type acetyl-Coenzyme A carboxylase at amino acid position 1999(*Am*). Wild-type *A. myosuroides* acetyl-Coenzyme A carboxylase has a tryptophan at position 1999(*Am*). Acetyl-Coenzyme A carboxylase enzymes of the invention will typically have an amino acid other than tryptophan at this position. Suitable examples of amino acids that may be found at this position in the acetyl-Coenzyme A carboxylase enzymes of the invention include, but are not limited to, cysteine . In one embodiment, an acetyl-Coenzyme A carboxylase enzyme of the invention will have a cysteine at 1999(*Am*).

[0077] In one embodiment, an acetyl-Coenzyme A carboxylase of the invention differs from the corresponding wild-type acetyl-Coenzyme A carboxylase at amino acid position 2027(*Am*). Wild-type *A. myosuroides* acetyl-Coenzyme A carboxylase has a tryptophan at position 2027(*Am*). Acetyl-Coenzyme A carboxylase enzymes of the invention will typically have an amino acid other than tryptophan at this position. Suitable examples of amino acids that may be found at this position in the acetyl-Coenzyme A carboxylase enzymes of the invention include, but are not limited to, cysteine. In one embodiment, an acetyl-Coenzyme A carboxylase enzyme of the invention will have a cysteine at 2027(*Am*).

[0078] In one embodiment, an acetyl-Coenzyme A carboxylase of the invention differs from the corresponding wild-type acetyl-Coenzyme A carboxylase at amino acid position 2041(*Am*). Wild-type *A. myosuroides* acetyl-Coenzyme A carboxylase has an isoleucine at position 2041(*Am*). Acetyl-Coenzyme A carboxylase enzymes of the invention will typically have an amino acid other than isoleucine at this position. Suitable examples of amino acids that may be found at this position in the acetyl-Coenzyme A carboxylase enzymes of the invention include, but are not limited to, asparagine. In one embodiment, an acetyl-Coenzyme A carboxylase enzyme of the invention will have an asparagine at 2041(*Am*).

[0079] In one embodiment, an acetyl-Coenzyme A carboxylase of the invention differs from the corresponding wild-type acetyl-Coenzyme A carboxylase at amino acid position 2078(*Am*). Wild-type *A. myosuroides* acetyl-Coenzyme A carboxylase has an aspartate at position 2078(*Am*). Acetyl-Coenzyme A carboxylase enzymes of the invention will typically have an amino acid other than aspartate at this position. Suitable examples of amino acids that may be found at this position in the acetyl-Coenzyme A carboxylase enzymes of the invention include, but are not limited to, glycine. In one embodiment, an acetyl-Coenzyme A carboxylase enzyme of the invention will have a glycine at 2078(*Am*).

[0080] In one embodiment, an acetyl-Coenzyme A carboxylase of the invention differs from the corresponding wild-type acetyl-Coenzyme A carboxylase at amino acid position 2088(*Am*). Wild-type *A. myosuroides* acetyl-Coenzyme A carboxylase has a cysteine at position 2088(*Am*). Acetyl-Coenzyme A carboxylase enzymes of the invention will typically have an amino acid other than cysteine at this position. Suitable examples of amino acids that may be found at this position in the acetyl-Coenzyme A carboxylase enzymes of the invention include, but are not limited to, arginine. In one embodiment, an acetyl-Coenzyme A carboxylase enzyme of the invention will have an arginine at 2088(*Am*).

[0081] In one embodiment, an acetyl-Coenzyme A carboxylase of the invention differs from the corresponding wild-type acetyl-Coenzyme A carboxylase at amino acid position 2096(*Am*). Wild-type *A. myosuroides* acetyl-Coenzyme A carboxylase has a glycine at position 2096(*Am*). Acetyl-Coenzyme A carboxylase enzymes of the invention will typically have an amino acid other than glycine at this position. Suitable examples of amino acids that may be found at this position in the acetyl-Coenzyme A carboxylase enzymes of the invention include, but are not limited to, alanine. In one embodiment, an acetyl-Coenzyme A carboxylase enzyme of the invention will have an alanine at 2096(*Am*).

[0082] The present invention also encompasses acetyl-Coenzyme A carboxylase enzymes with an amino acid sequence that differs in more than one amino acid position from that of the acetyl-Coenzyme A carboxylase enzyme found in the corresponding wild-type plant. For example, an acetyl-Coenzyme A carboxylase of the invention may differ in 2, 3, 4, 5, 6, or 7 positions from that of the acetyl-Coenzyme A carboxylase enzyme found in the corresponding wild-type plant.

[0083] In one embodiment, an acetyl-Coenzyme A carboxylase of the invention differs from the corresponding wild-type acetyl-Coenzyme A carboxylase at amino acid position 1781(*Am*) and at one or more additional amino acid positions. Acetyl-Coenzyme A carboxylase enzymes of the invention will typically have a leucine or an alanine at position 1781(*Am*). In addition, enzymes of this embodiment will also comprise one or more of a cysteine at position 1999(*Am*), a cysteine at position 2027(*Am*), an asparagine at position

2041(*Am*), a glycine at position 2078(*Am*), an arginine at position 2088(*Am*), and an alanine at position 2096(*Am*). In one embodiment, an acetyl-Coenzyme A carboxylase of the invention will have a leucine or an alanine at position 1781(*Am*) and a cysteine at position 2027(*Am*). In one embodiment, an acetyl-Coenzyme A carboxylase of the invention will have a leucine or an alanine at position 1781(*Am*) and an asparagine at position 2041(*Am*). In one embodiment, an acetyl-Coenzyme A carboxylase of the invention will have a leucine or an alanine at position 1781(*Am*) and an alanine at position 2096(*Am*). In one embodiment, an acetyl-Coenzyme A carboxylase of the invention will have a leucine or an alanine at position 1781(*Am*), a cysteine at position 2027(*Am*), and an asparagine at position 2041(*Am*). In one embodiment, an acetyl-Coenzyme A carboxylase of the invention will have a leucine or an alanine at position 1781(*Am*), a cysteine at position 2027(*Am*), an asparagine at position 2041(*Am*), and an alanine at position 2096(*Am*).

[0084] In one embodiment, an acetyl-Coenzyme A carboxylase of the invention differs from the corresponding wild-type acetyl-Coenzyme A carboxylase at amino acid position 1999(*Am*) and at one or more additional amino acid positions. Acetyl-Coenzyme A carboxylase enzymes of the invention will typically have a cysteine at position 1999(*Am*). In addition, enzymes of this embodiment will also comprise one or more of a leucine or alanine at position 1781(*Am*), a cysteine at position 2027(*Am*), an asparagine at position 2041(*Am*), a glycine at position 2078(*Am*), an arginine at position 2088(*Am*), and an alanine at position 2096. In one embodiment, an acetyl-Coenzyme A carboxylase of the invention will have a cysteine at position 1999(*Am*) and a leucine or alanine at position 1781(*Am*) and a cysteine at position 2027(*Am*). In one embodiment, an acetyl-Coenzyme A carboxylase of the invention will have a cysteine at position 1999(*Am*) and a leucine or alanine at position 1781(*Am*) and an asparagine at position 2041(*Am*). In one embodiment, an acetyl-Coenzyme A carboxylase of the invention will have a cysteine at position 1999(*Am*) and a leucine or alanine at position 1781(*Am*), a cysteine at position 2027(*Am*), and an asparagine at position 2041(*Am*).

[0085] In one embodiment, an acetyl-Coenzyme A carboxylase of the invention differs from the corresponding wild-type acetyl-Coenzyme A carboxylase at amino acid position 2027(*Am*) and at one or more additional amino acid positions. Acetyl-Coenzyme A carboxylase enzymes of the invention will typically have a cysteine at position 2027(*Am*). In addition, enzymes of this embodiment will also comprise one or more of a leucine or alanine at position 1781(*Am*), a cysteine at position 1999(*Am*), an asparagine at position 2041(*Am*), a glycine at position 2078(*Am*), an arginine at position 2088(*Am*), and an alanine at position 2096(*Am*). In one embodiment, an acetyl-Coenzyme A carboxylase of the invention will have a cysteine at position 2027(*Am*) and a leucine or an alanine at position 1781(*Am*).

[0086] In one embodiment, an acetyl-Coenzyme A carboxylase of the invention differs from the corresponding wild-type acetyl-Coenzyme A carboxylase at amino acid position 2041(*Am*) and at one or more additional amino acid positions. Acetyl-Coenzyme A carboxylase enzymes of the invention will typically have an isoleucine at position 2041(*Am*). In addition, enzymes of this embodiment will also comprise one or more of a leucine or alanine at position 1781(*Am*), a cysteine at position 1999(*Am*), a cysteine at position 2027(*Am*), a glycine at position 2078(*Am*), an arginine at position 2088(*Am*), and an alanine at position 2096(*Am*). In one embodiment, an acetyl-Coenzyme A carboxylase of the invention will have an asparagine at position 2041(*Am*) and a leucine or alanine at position 1781(*Am*).

[0087] In one embodiment, an acetyl-Coenzyme A carboxylase of the invention differs from the corresponding wild-type acetyl-Coenzyme A carboxylase at amino acid position 2078(*Am*) and at one or more additional amino acid positions. Acetyl-Coenzyme A carboxylase enzymes of the invention will typically have a glycine at position 2078(*Am*). In addition, enzymes of this embodiment will also comprise one or more of a leucine or alanine at position 1781(*Am*), a cysteine at position 1999(*Am*), a cysteine at position 2027(*Am*), an asparagine at position 2041(*Am*), an arginine at position 2088(*Am*), and an alanine at position 2096(*Am*). In one embodiment, an acetyl-Coenzyme A carboxylase of the invention will have a glycine at position 2078(*Am*) and a leucine or alanine at position 1781(*Am*). In one embodiment, an acetyl-Coenzyme A carboxylase of the invention will have a glycine at position 2078(*Am*) and an alanine at position 2096(*Am*).

[0088] In one embodiment, an acetyl-Coenzyme A carboxylase of the invention differs from the corresponding wild-type acetyl-Coenzyme A carboxylase at amino acid position 2088(*Am*) and at one or more additional amino acid positions. Acetyl-Coenzyme A carboxylase enzymes of the invention will typically have an arginine at position 2088(*Am*).

In addition, enzymes of this embodiment will also comprise one or more of a leucine or alanine at position 1781(*Am*), a cysteine at position 1999(*Am*), a cysteine at position 2027(*Am*), an asparagine at position 2041(*Am*), a glycine at position 2078(*Am*), and an alanine at position 2096(*Am*). In one embodiment, an acetyl-Coenzyme A carboxylase of the invention will have an arginine at position 2088(*Am*) and a leucine or alanine at position 1781(*Am*). In one embodiment, an acetyl-Coenzyme A carboxylase of the invention will have an arginine at position 2088(*Am*) and an alanine at position 2096(*Am*).

[0089] In one embodiment, an acetyl-Coenzyme A carboxylase of the invention differs from the corresponding wild-type acetyl-Coenzyme A carboxylase at amino acid position 2096(*Am*) and at one or more additional amino acid positions. Acetyl-Coenzyme A carboxylase enzymes of the invention will typically have an alanine at position 2096(*Am*). In addition, enzymes of this embodiment will also comprise one or more of a leucine or alanine at position 1781(*Am*), a cysteine at position 1999(*Am*), a cysteine at position 2027(*Am*), an asparagine at position 2041(*Am*), a glycine at position 2078(*Am*), and an arginine at position 2088(*Am*). In one embodiment, an acetyl-Coenzyme A carboxylase of the invention will have an alanine at position 2096(*Am*) and a leucine or alanine at position 1781(*Am*). In one embodiment, an acetyl-Coenzyme A carboxylase of the invention will have an alanine at position 2096(*Am*) and an alanine at position 2096(*Am*).

[0090] Nucleic acid molecules

[0091] The present invention also encompasses nucleic acid molecules that encode all or a portion of the acetyl-Coenzyme A carboxylase enzymes described above. Nucleic acid molecules of the invention may comprise a nucleic acid sequence encoding an amino acid sequence comprising a modified version of one or both of SEQ ID NOs: 2 and 3, wherein the sequence is modified such that the encoded protein comprises one or more of the following: the amino acid at position 1,781(*Am*) is leucine or alanine; the amino acid at position 1,999(*Am*) is cysteine; the amino acid at position 2,027(*Am*) is cysteine; the amino acid at position 2,041(*Am*) is asparagine; the amino acid at position 2,078(*Am*) is glycine; the amino acid at position 2088(*Am*) is arginine or the amino acid at position 2,096(*Am*) is alanine, as well as nucleic acid molecules complementary to all or a portion of the coding sequences. In some embodiments, a nucleic acid molecule of the invention may encode an acetyl-

Coenzyme A carboxylase having multiple differences from the wild type acetyl-Coenzyme A carboxylase as described above.

[0092] In one embodiment, a nucleic acid molecule of the invention may encode an acetyl-Coenzyme A carboxylase comprising a leucine or an alanine at position 1781(*Am*) and a cysteine at position 2027(*Am*). In one embodiment, a nucleic acid molecule of the invention may encode an acetyl-Coenzyme A carboxylase comprising a leucine or an alanine at position 1781(*Am*) and an asparagine at position 2041(*Am*). In one embodiment, a nucleic acid molecule of the invention may encode an acetyl-Coenzyme A carboxylase comprising a leucine or an alanine at position 1781(*Am*) and an alanine at position 2096(*Am*). In one embodiment, a nucleic acid molecule of the invention may encode an acetyl-Coenzyme A carboxylase comprising a leucine or an alanine at position 1781(*Am*), a cysteine at position 2027(*Am*), and an asparagine at position 2041(*Am*). In one embodiment, a nucleic acid molecule of the invention may encode an acetyl-Coenzyme A carboxylase comprising a leucine or an alanine at position 1781(*Am*), a cysteine at position 2027(*Am*), an asparagine at position 2041(*Am*), and an alanine at position 2096(*Am*).

[0093] A nucleic acid molecule of the invention may be DNA, derived from genomic DNA or cDNA, or RNA. A nucleic acid molecule of the invention may be naturally occurring or may be synthetic. A nucleic acid molecule of the invention may be isolated, recombinant and/or mutagenized.

[0094] In one embodiment, a nucleic acid molecule of the invention encodes an acetyl-Coenzyme A carboxylase enzyme in which the amino acid at 1781(*Am*) is leucine or alanine or is complementary to such a nucleic acid molecule. Such nucleic acid molecules include, but are not limited to, genomic DNA that serves as a template for a primary RNA transcription, a plasmid molecule encoding the acetyl-Coenzyme A carboxylase, as well as an mRNA encoding such an acetyl-Coenzyme A carboxylase.

[0095] Nucleic acid molecules of the invention may comprise non-coding sequences, which may or may not be transcribed. Non-coding sequences that may be included in the nucleic acid molecules of the invention include, but are not limited to, 5' and 3' UTRs, polyadenylation signals and regulatory sequences that control gene expression (e.g., promoters). Nucleic acid molecules of the invention may also comprise sequences encoding transit peptides, protease cleavage sites, covalent modification sites and the like. In one embodiment, nucleic acid molecules of the invention encode a chloroplast transit peptide sequence in addition to a sequence encoding an acetyl-Coenzyme A carboxylase enzyme.

[0096] In another embodiment, nucleic acid molecules of the invention may encode an acetyl-Coenzyme A carboxylase enzyme having at least 50%, 60%, 70%, 75%, 80%, 85%, 90%, 95% or more sequence identity to a modified version of one or both of SEQ ID NOs: 2 and 3, wherein the sequence is modified such that the encoded protein comprises one or more of the following: the amino acid at position 1,781(*Am*) is leucine or alanine; the amino acid at position 1,999(*Am*) is cysteine; the amino acid at position 2,027(*Am*) is cysteine; the amino acid at position 2,041(*Am*) is asparagine; the amino acid at position 2,078(*Am*) is glycine; the amino acid at position 2088(*Am*) is arginine or the amino acid at position 2,096(*Am*) is alanine, as well as nucleic acid molecules complementary to all or a portion of the coding sequences.

[0097] As used herein, "percent (%) sequence identity" is defined as the percentage of nucleotides or amino acids in the candidate derivative sequence identical with the nucleotides or amino acids in the subject sequence (or specified portion thereof), after aligning the sequences and introducing gaps, if necessary to achieve the maximum percent sequence identity, as generated by the program BLAST available at http://blast.ncbi.nlm.nih.gov/Blast.cgi with search parameters set to default values.

[0098] The present invention also encompasses nucleic acid molecules that hybridize to nucleic acid molecules encoding acetyl-Coenzyme A carboxylase of the invention as well as nucleic acid molecules that hybridize to the reverse complement of nucleic acid molecules encoding an acetyl-Coenzyme A carboxylase of the invention. In one embodiment, nucleic acid molecules of the invention comprise nucleic acid molecules that hybridize to a nucleic acid molecule encoding one or more of a modified version of one or both of SEQ ID NOs: 2 and 3, wherein the sequence is modified such that the encoded protein comprises one or more of the following: the amino acid at position 1,781(*Am*) is leucine or alanine; the amino acid at position 1,999(*Am*) is cysteine; the amino acid at position 2,027(*Am*) is cysteine; the amino acid at position 2,041(*Am*) is asparagine; the amino acid at position 2,078(*Am*) is glycine; the amino acid at position 2088(*Am*) is arginine or the amino acid at position 2,096(*Am*) is alanine, as well as nucleic acid molecules complementary to all or a portion of the coding sequences, or the reverse complement of such nucleic acid molecules under stringent conditions. The stringency of hybridization can be controlled by temperature, ionic strength, pH, and the presence of denaturing agents such as formamide during hybridization and washing. Stringent conditions that may be used include those defined in *Current Protocols in Molecular Biology*, Vol. 1, Chap. 2.10, John Wiley & Sons, Publishers (1994) and Sambrook et al., *Molecular Cloning*, Cold Spring Harbor (1989) which are specifically incorporated herein as they relate to teaching stringent conditions.

[0099] In one embodiment, nucleic acid molecules invention encompasses oligonucleotides that may be used as hybridization probes, sequencing primers, and/or PCR primers. Such oligonucleotides may be used, for example, to determine a codon sequence at a particular position in a nucleic acid molecule encoding an acetyl-Coenzyme A carboxylase, for example, by allele specific PCR. Such oligonucleotides may be from about 15 to about 30, from about 20 to about 30, or from about 20-25 nucleotides in length.

[0100] Herbicides

[0101] The present invention provides plants, e.g., rice plants, that are tolerant of concentrations of herbicide that normally inhibit the growth of wild-type plants. The plants are typically resistant to herbicides that interfere with acetyl-Coenzyme A carboxylase activity. Any herbicide that inhibits acetyl-Coenzyme A carboxylase activity can be used in conjunction with the plants of the invention. Suitable examples include, but are not limited to, cyclohexanedione herbicides, aryloxyphenoxy propionate herbicides, and phenylpyrazole herbicides. In some methods of controlling weeds and/or growing herbicide-tolerant plants, at least one herbicide is selected from the group consisting of sethoxydim, cycloxydim, tepraloxydim, haloxyfop, or a derivative of any of these herbicides.

[0102] Table 4 provides a list of cyclohexanedione herbicides (DIMs, also referred to as: cyclohexene oxime cyclohexanedione oxime; and CHD) that interfere with acetyl-Coenzyme A carboxylase activity and may be used in conjunction with the herbicide-tolerant plants of the invention. One skilled in the art will recognize that other herbicides in this class exist and may be used in conjunction with the herbicide-tolerant plants of the invention.

[0103] Table 4

Active Name	Synonyms	Example Products
Alloxydim	Carbodimedon, Zizalon, BAS 90210H	
Butroxydim	Butoxydim	Falcon
Caloxydim		
Clethodim	Cletodime	Select; Prism; Centurion
Cloproxydim		
Cycloxydim	BAS 517H, BAS 517	Focus
Profoxydim	Clefoxydim, BAS 625H, BAS 625	Aura
Sethoxydim	Cyethoxydim, BAS 562H, BASF 620	Poast; Rezult; Vantage
Tepraloxydim	BAS 620H, BAS 620	Aramo
Tralkoxydim	Tralkoxydime; Tralkoxidym	Achieve; Splendor

[0104] Table 5 presents a list of aryloxyphenoxy propionate herbicides (also referred to as aryloxyphenoxy propanoate; aryloxyphenoxyalkanoate; oxyphenoxy; APP; AOPP; APA; APPA; FOP, note that these are sometime written with the suffix '-oic') that interfere with acetyl-Coenzyme A carboxylase activity and may be used in conjunction with the herbicide-tolerant plants of the invention. One skilled in the art will recognize that other herbicides in this class exist and may be used in conjunction with the herbicide-tolerant plants of the invention.

[0105] Table 5

Active Name	Synonyms	Example Products
Chlorazifop		
Clodinafop		Discover, Topik
Clofop	Fenofibric Acid	Alopex
Cyhalofop		Barnstorm; Clincher
Diclofop	Dichlorfop; Illoxan	Hoelon; Hoegrass
Fenoxaprop	Fenoxaprop-P	Option; Fusion; Acclaim
Fenthiaprop		Taifun; Joker
Fluazifop	Fluazifop-P	Fusilade DX; Fusion
Haloxyfop	Haloxyfop-P	Motsa; Verdict; Gallant
Isoxapyrifop		
Metamifop		
Propaquizafop		Correct; Shogun
Quizalofop	Quizalofop-P; Quizafop	Assure; Targa
Trifop		

[0106] In addition to the herbicides listed above, any other herbicide that interferes with acetyl-Coenzyme A carboxylase activity may be used in conjunction with the herbicide-tolerant plants of the invention. One example is phenylpyrazoline (also known as DEN; and sometimes referred to under the more general class of Phenylpyrazole). An example of such an herbicide is pinoxaden and it is sold under the tradename Axial.

[0107] Those skilled in the art will recognize that any derivative of the above mentioned herbicides that inhibits acetyl-Coenzyme A carboxylase activity can be used in the practice of the invention.

[0108] In addition, any of the above acetyl-Coenzyme A carboxylase-inhibiting herbicides can be combined with one or more herbicides of another class, for example, any of the acetohydroxyacid synthase-inhibiting herbicides, EPSP synthase-inhibiting herbicides, glutamine synthase-inhibiting herbicides, lipid- or pigment-biosynthesis inhibitor herbicides, cell-membrane disruptor herbicides, photosynthesis or respiration inhibitor herbicides, or growth regulator or growth inhibitor herbicides known in the art. Non-limiting examples include those recited in Weed Science Society of America's *Herbicide Handbook*, 9th Edition edited by S.A. Senseman, copy right 2007. An herbicidal composition herein can contain one or more agricultural active ingredient(s) selected from the agriculturally-acceptable fungicides, insecticides (including nematicides), miticides, and molluscicides. Non-limiting examples include those recited in 2009 Crop Protection Reference (www.greenbook.net), Vance Publications.

[0109] The herbicide compositions containing such active ingredient(s) can be provided in any of the various formulations known useful in the art. Examples, include suspensions, emulsions, granules, dusts, solutions, and the like.

[0110] Methods of controlling weeds

[0111] Herbicide-tolerant plants of the invention may be used in conjunction with an herbicide to which they are tolerant. Herbicides may be applied to the plants of the invention using any techniques known to those skilled in the art. Herbicides may be applied at any point in the plant cultivation process. For example, herbicides may be applied pre-planting, at planting, pre-emergence, post-emergence or combinations thereof.

[0112] Herbicide compositions hereof can be applied, e.g., as foliar treatments, soil treatments, seed treatments, or soil drenches. Application can be made, e.g., by spraying, dusting, broadcasting, or any other mode known useful in the art.

[0113] In one embodiment, herbicides may be used to control the growth of weeds that may be found growing in the vicinity of the herbicide-tolerant plants invention. In embodiments of this type, an herbicide may be applied to a plot in which herbicide-tolerant plants of the invention are growing in vicinity to weeds. An herbicide to which the herbicide-tolerant plant of the invention is tolerant may then be applied to the plot at a concentration sufficient to kill or inhibit the growth of the weed. Concentrations of herbicide sufficient to kill or inhibit the growth of weeds are known in the art.

[0114] It will be readily apparent to one of ordinary skill in the relevant arts that other suitable modifications and adaptations to the methods and applications described herein are obvious and may be made without departing from the scope of the invention or any embodiment thereof. Having now described the present invention in detail, the same will be more clearly understood by reference to the following examples, which are included herewith for purposes of illustration only and are not intended to be limiting of the invention.

EXAMPLES

EXAMPLE 1

[0115] Tissue culture conditions

[0116] An *in vitro* tissue culture mutagenesis assay has been developed to isolate and characterize plant tissue (e.g., rice tissue) that is tolerant to acetyl-Coenzyme A carboxylase inhibiting herbicides, e.g., tepraloxydim, cycloxydim, and sethoxydim. The assay utilizes the somaclonal variation that is found in *in vitro* tissue culture. Spontaneous mutations derived from somaclonal variation can be enhanced by chemical mutagenesis and subsequent selection in a stepwise manner, on increasing concentrations of herbicide.

[0117] The present invention provides tissue culture conditions for encouraging growth of friable, embryogenic rice callus that is regenerable. Calli were initiated from 4 different rice cultivars encompassing both Japonica (Taipei 309, Nipponbare, Koshihikari) and Indica

(Indica 1) varieties. Dehusked seed were surface sterilized in 70% ethanol for approximately 1 min followed by 20% commercial Clorox bleach for 20 minutes. Seeds were rinsed with sterile water and plated on callus induction media. Various callus induction media were tested. The ingredient lists for the media tested are presented in Table 6.

[0118] Table 6

Ingredient	Supplier	R001M	R025M	R026M	R327M	R008M	MS711R
B5 Vitamins	Sigma					1.0 X	
MS salts	Sigma			1.0 X	1.0 X	1.0 X	1.0 X
MS Vitamins	Sigma			1.0 X	1.0 X		
N6 salts	Phytotech	4.0 g/L	4.0g/L				
N6 vitamins	Phytotech	1.0 X	1.0 X				
L-Proline	Sigma	2.9 g/L	0.5 g/L				1.2 g/L
Casamino Acids	BD	0.3 g/L	0.3 g/L	2 g/L			
Casein Hydrolysate	Sigma						1.0 g/L
L-Asp Monohydrate	Phytotech						150 mg/L
Nicotinic Acid	Sigma						0.5 mg/L
Pyridoxine HCl	Sigma						0.5 mg/L
Thiamine HCl	Sigma						1.0 mg/L
Myo-inositol	Sigma						100 mg/L
MES	Sigma	500 mg/L	500 mg/L	500 mg/L	500 mg/L	500 mg/L	500 mg/L
Maltose	VWR	30 g/L	30 g/L	30 g/L	30 g/L		
Sorbitol	Duchefa			30 g/L			
Sucrose	VWR					10 g/L	30 g/L
NAA	Duchefa					50 μg/L	
2,4-D	Sigma	2.0 mg/L					1.0 mg/L
$MgCl_2 \cdot 6H_2O$	VWR					750 mg/L	
→pH		5.8	5.8	5.8	5.8	5.8	5.7
Gelrite	Duchefa	4.0 g/L				2.5 g/L	
Agarose Type1	Sigma		7.0 g/L	10 g/L	10 g/L		
→Autoclave		15 min	15 min	15 min	15 min	15 min	20 min
Kinetin	Sigma		2.0 mg/L	2.0 mg/L			
NAA	Duchefa		1.0 mg/L	1.0 mg/L			
ABA	Sigma		5.0 mg/L				
Cefotaxime	Duchefa		0.1 g/L	0.1 g/L	0.1 g/L		
Vancomycin	Duchefa		0.1 g/L	0.1 g/L	0.1 g/L		
G418 Disulfate	Sigma		20 mg/L	20 mg/L	20 mg/L		

[0119] R001M callus induction media was selected after testing numerous variations. Cultures were kept in the dark at 30°C. Embryogenic callus was subcultured to fresh media after 10-14 days.

EXAMPLE 2

[0120] Selection of herbicide-tolerant calli

[0121] Once tissue culture conditions were determined, further establishment of selection conditions were established through the analysis of tissue survival in kill curves with cycloxydim, tepraloxydim, sethoxydim (Figure 1) or haloxyfop (not shown). Careful consideration of accumulation of the herbicide in the tissue, as well as its persistence and stability in the cells and the culture media was performed. Through these experiments, a sub-lethal dose has been established for the initial selection of mutated material.

[0122] After the establishment of the starting dose of sethoxydim, cycloxydim, tepraloxydim, and haloxyfop in selection media, the tissues were selected in a step-wise fashion by increasing the concentration of the ACCase inhibitor with each transfer until cells are recovered that grew vigorously in the presence of toxic doses (see Figure 2). The resulting calli were further subcultured every 3-4 weeks to R001M with selective agent. Over 26,000 calli were subjected to selection for 4-5 subcultures until the selective pressure was above toxic levels as determined by kill curves and observations of continued culture. Toxic levels were determined to be 50 μM sethoxydim, 20 μM cycloxydim, 2.5 μM tepraloxydim (Figure 1) and 10 μM haloxyfop (not shown).

[0123] Alternatively, liquid cultures initiated from calli in MS711R (Table 5) with slow shaking and weekly subcultures. Once liquid cultures were established, selection agent was added directly to the flask at each subculture. Following 2-4 rounds of liquid selection, cultures were transferred to filters on solid R001M media for further growth.

EXAMPLE 3

[0124] Regeneration of plants

[0125] Tolerant tissue was regenerated and characterized molecularly for ACCase gene sequence mutations and/or biochemically for altered ACCase activity in the presence of the selective agent.

[0126] Following herbicide selection, calli were regenerated using a media regime of R025M for 10 – 14 days, R026M for ca. 2 weeks, R327M until well formed shoots were developed, and R008S until shoots were well rooted for transfer to the greenhouse (Table 5). Regeneration was carried out in the light. No selection agent was included during regeneration.

[0127] Once strong roots were established, M0 regenerants were transplant to the greenhouse in 4" square pots in a mixture of sand, NC Sandhills loamy soil, and Redi-earth (2:4:6) supplemented with gypsum. Transplants were maintained under a clear plastic cup until they were adapted to greenhouse conditions (ca. 1 week). The greenhouse was set to a day/night cycle of 27°C/21°C (80°F/70°F) with 600W high pressure sodium lights supplementing light to maintain a 14 hour day length. Plants were watered 2-3 times a day depending in the weather and fertilized daily. Rice plants selected for seed increase were transplanted into one gallon pots. As plants approached maturity and prepared to bolt, the pots were placed in small flood flats to better maintain water and nutrient delivery. Plants were monitored for insects and plant health and managed under standard Integrated Pest Management practices.

EXAMPLE 4

[0128] Sequence analysis

[0129] Leaf tissue was collected from clonal plants separated for transplanting and analyzed as individuals. Genomic DNA was extracted using a Wizard® 96 Magnetic DNA Plant System kit (Promega, US Patent Nos. 6,027,945 & 6,368,800) as directed by the manufacturer. Isolated DNA was PCR amplified using one forward and one reverse primer.

[0130] Forward Primers:

[0131] OsACCpU5142: 5'-GCAAATGATATTACGTTCAGAGCTG-3' (SEQ ID NO:7)

[0132] OsACCpU5205: 5'-GTTACCAACCTAGCCTGTGAGAAG-3' (SEQ ID NO: 8)

[0133] Reverse Primers:

[0134] OsACCpL7100: 5'-GATTTCTTCAACAAGTTGAGCTCTTC-3' (SEQ ID NO: 9)

[0135] OsACCpL7054: 5'-AGTAACATGGAAAGACCCTGTGGC-3' (SEQ ID NO: 10)

[0136] PCR amplification was performed using Hotstar Taq DNA Polymerase (Qiagen) using touchdown thermocycling program as follows: 96°C for 15 min, followed by 35 cycles (96°C, 30 sec; 58°C – 0.2 °C per cycle, 30 sec; 72°C, 3 min and 30 sec), 10 min at 72°C.

[0137] PCR products were verified for concentration and fragment size via agarose gel electrophoresis. Dephosphorylated PCR products were analyzed by direct sequence using the PCR primers (DNA Landmarks). Chromatogram trace files (.scf) were analyzed for mutation relative to Os05g0295300 using Vector NTI Advance 10™ (Invitrogen). Based on sequence information, two mutations were identified in several individuals. I1781L and D2078G were present in the heterozygous state. Sequence analysis was performed on the representative chromatograms and corresponding AlignX alignment with default settings and edited to call secondary peaks.

[0138] Samples inconsistent with an ACCase mutation were spray tested for tolerance and discarded as escapes. Surprisingly, most of the recovered lines were heterozygous for the I1781L mutation and resistant events were generated in all tested genotypes using cycloxydim or sethoxydim: Indica1 (≥18 lines), Taipei 309 (≥14 lines), Nipponbare (≥3 lines), and Koshihikare (≥6 lines). One line was heterozygous for a D2078G mutation. The D2078G heterozygote line appeared stunted with narrow leaves, while the I1781L heterozygotes varied in appearance, but most looked normal relative to their parental genotype. Several escapes were recovered and confirmed by sequencing and spray testing; however, sequencing results of the herbicide sensitive region of ACCase revealed that most tolerant mutants were heterozygous for an I1781L, A to T mutation. One line, ARWI010, was heterozygous for a D2078G, A to G mutation. To date, all recovered plants lacking an ACCase mutation have been sensitive to herbicide application in the greenhouse.

EXAMPLE 5

[0139] Demonstration of herbicide-tolerance

[0140] Selected mutants and escapes were transferred to small pots. Wild-type cultivars and 3 biovars of red rice were germinated from seed to serve as controls.

[0141] After ca. 3 weeks post-transplant, M0 regenerants were sprayed using a track sprayer with 400-1600 g ai/ha cycloxydim (BAS 517H) supplemented with 0.1% methylated seed oil. After the plants had adapted to greenhouse conditions, a subset were sprayed with 800 g ai/ha cycloxydim. Once sprayed, plants were kept on drought conditions for 24 hours before being watered and fertilized again. Sprayed plants were photographed and rated for herbicide injury at 1 (Figure 3) and 2 weeks after treatment (Figure 4). No injury was observed on plants containing the I1781L heterozygous mutation while control plants and tissue culture escapes (regenerated plants negative for the sequenced mutations) were heavily damaged after treatment (Figures 3 & 4). Figures 5-16 provide nucleic acid and/or amino acid sequences of acetyl-Coenzyme A carboxylase enzymes from various plants.

[0142] While the foregoing invention has been described in some detail for purposes of clarity and understanding, it will be appreciated by one skilled in the art from a reading of this disclosure that various changes in form and detail can be made without departing from the true scope of the invention and appended claims. All patents and publications cited herein are entirely incorporated herein by reference.

What is claimed is:

1. A rice plant tolerant to at least one herbicide that inhibits acetyl-Coenzyme A carboxylase activity at levels of herbicide that would normally inhibit the growth of a rice plant.

2. A rice plant that expresses an acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid sequence differs from an amino acid sequence of an acetyl-Coenzyme A carboxylase of a wild-type rice plant at one or more of the following positions: 1,781(*Am*), 1,999(*Am*), 2,027(*Am*), 2,041(*Am*), 2,078(*Am*), 2088(*Am*) or 2,096(*Am*).

3. A rice plant, wherein said plant expresses an acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid sequence comprises one or more of the following: the amino acid at position 1,781(*Am*) is other than isoleucine; the amino acid at position 1,999(*Am*) is other than tryptophan; the amino acid at position 2,027(*Am*) is other than tryptophan; the amino acid at position 2,041(*Am*) is other than isoleucine; the amino acid at position 2,078(*Am*) is other than aspartate; the amino acid at position 2088(*Am*) is other than cysteine; or the amino acid at position 2,096(*Am*) is other than glycine.

4. A rice plant, wherein said plant expresses an acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid sequence comprises one or more of the following: the amino acid at position 1,781(*Am*) is leucine or alanine; the amino acid at position 1,999(*Am*) is cysteine; the amino acid at position 2,027(*Am*) is cysteine; the amino acid at position 2,041(*Am*) is asparagine; the amino acid at position 2,078(*Am*) is glycine; the amino acid at position 2088(Am) is Arginine or the amino acid at position 2,096(*Am*) is alanine.

5. An herbicide-tolerant rice plant which is tolerant to at least one herbicide that inhibits acetyl-Coenzyme A carboxylase activity at levels of herbicide that would normally inhibit the growth of said plant, wherein the herbicide-tolerant plant is produced by:

a) obtaining cells from a plant that is not tolerant to the herbicide;

b) contacting the cells with a medium comprising one or more acetyl-Coenzyme A carboxylase inhibitors; and

c) generating an herbicide-tolerant plant from the cells;

wherein the herbicide-tolerant plant was generated by performing a), b) and c) or is a progeny of a plant generated by performing a), b), and c).

6. A rice plant, wherein one or more of the genomes of said rice plant encode a protein comprising an amino acid sequence comprising one or more of a modified SEQ ID NO:2 and a modified SEQ ID NO:3, wherein the sequence is modified such that the encoded protein comprises one or more of the following: the amino acid at position 1,781(*Am*) is leucine or alanine; the amino acid at position 1,999(*Am*) is cysteine; the amino acid at position 2,027(*Am*) is cysteine; the amino acid at position 2,041(*Am*) is asparagine; the amino acid at position 2,078(*Am*) is glycine; the amino acid at position 2088(*Am*) is arginine or the amino acid at position 2,096(*Am*) is alanine.

7. A rice plant wherein:

(a) growth of said plant is tolerant to acetyl-Coenzyme A carboxylase-inhibiting herbicides at levels of herbicide that would normally inhibit the growth of a rice plant;

(b) said plant is grown from a seed having ATCC accession number PTA-10267; or is a mutant, recombinant, or genetically engineered derivative of the plant grown from a seed having ATCC accession number PTA-10267 or of any progeny of the plant grown from a seed having ATCC accession number PTA-10267; or is a plant which is the progeny of any of these plants; and

(c) said plant has the herbicide tolerance characteristics of the plant grown from a seed having ATCC accession number PTA-10267.

8. An herbicide-tolerant rice plant according to claim 5, wherein the cells are in the form of a callus.

9. A plant of any one of claims claim 1, 2, 3, 4, 5, 6, or 7, wherein said plant is a member of the species *O. sativa*.

10. A rice plant according to any one of claims 1, 2, 3, 4, 5, 6, or 7, wherein growth of the plant is tolerant to aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof at levels of herbicide that would normally inhibit the growth of a rice plant.

11. A rice plant according to any one of claims 1, 2, 3, 4, 5, 6, or 7, wherein growth of the plant is tolerant to at least one herbicide is selected from the group consisting of alloxydim, butroxydim, caloxydim, clethodim, cloproxydim, cycloxydim, sethoxydim, tepraloxydim, tralkoxydim, chlorazifop, clodinafop, clofop, diclofop, fenoxaprop, fenthiaprop, fluazifop,

haloxyfop, isoxapyrifop, propaquizafop, quizalofop, trifop, and pinoxaden or a derivative of any of these herbicides at levels of herbicide that would normally inhibit the growth of a rice plant.

12. A rice plant according to any one of claims 1, 2, 3, 4, 5, 6, or 7, wherein growth of the plant is tolerant to an amount of one or more of sethoxydim, cycloxydim, tepraloxydim, haloxyfop, or a derivative of any of these herbicides at levels of herbicide that would normally inhibit the growth of a rice plant.

13. A rice plant according to any one of claims 1, 2, 3, 4, 5, 6, or 7, wherein said rice plant is not a GMO-plant.

14. A rice plant according to any one of claims 1, 2, 3, 4, 5, 6, or 7, wherein said rice plant is a mutagenized rice plant.

15. A cell from a rice plant according to any on of claims 1, 2, 3, 4, 5 6, or 7.

16. A method for controlling growth of weeds in vicinity to rice plants, comprising:

applying to the weeds and rice plants an amount of an acetyl-Coenzyme A carboxylase-inhibiting herbicide that inhibits naturally occurring acetyl-Coenzyme A carboxylase activity, wherein said rice plants comprise altered acetyl-Coenzyme A carboxylase activity such that said rice plants are tolerant to the applied amount of herbicide.

17. The method of claim 16, wherein said acetyl-Coenzyme A carboxylase-inhibiting herbicide is selected from the group consisting of aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof.

18. The method according to claim 16, wherein at least one herbicide is selected from the group consisting of alloxydim, butroxydim, caloxydim, clethodim, cloproxydim, cycloxydim, sethoxydim, tepraloxydim, tralkoxydim, chlorazifop, clodinafop, clofop, diclofop, fenoxaprop, fenthiaprop, fluazifop, haloxyfop, isoxapyrifop, propaquizafop, quizalofop, trifop, and pinoxadenor or a derivative of any of these herbicides.

19. The method according to claim 16, wherein at least one herbicide is selected from the group consisting of sethoxydim, cycloxydim, tepraloxydim, haloxyfop, or a derivative of any of these herbicides that would normally inhibit the growth of a rice plant.

20. A method for controlling growth of weeds in vicinity to rice plants, comprising:

applying one or more herbicides to the weeds and to the rice plants at levels of herbicide that would normally inhibit the growth of a rice plant, wherein at least one herbicide inhibits acetyl-Coenzyme A carboxylase activity.

21. A method according to claim 20, wherein at least one herbicide is selected from the group consisting of aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof.

22. A method according to claim 20, wherein at least one herbicide is selected from the group consisting of alloxydim, butroxydim, caloxydim, clethodim, cloproxydim, cycloxydim, sethoxydim, tepraloxydim, tralkoxydim, chlorazifop, clodinafop, clofop, diclofop,fenoxaprop, fenthiaprop, fluazifop, haloxyfop, isoxapyrifop, propaquizafop, quizalofop, trifop, and pinoxaden, or a derivative of any of these herbicides.

23. A method according to claim 20, wherein at least one herbicide is selected from the group consisting of sethoxydim, cycloxydim, tepraloxydim, haloxyfop, or a derivative of any of these herbicides.

24. A method for controlling growth of weeds, comprising:

(a) crossing an herbicide-tolerant rice plant with other rice germplasm, and harvesting the resulting hybrid rice seed;

(b) planting the hybrid rice seed; and

(c) applying one or more acetyl-Coenzyme A carboxylase-inhibiting herbicides to the hybrid rice and to the weeds in vicinity to the hybrid rice at levels of herbicide that would normally inhibit the growth of a rice plant.

25. A method according to claim 24, wherein at least one herbicide is selected from the group consisting of aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof.

26. A method according to claim 24, wherein at least one herbicide is selected from the group consisting of alloxydim, butroxydim, caloxydim, clethodim, cloproxydim, cycloxydim, sethoxydim, tepraloxydim, tralkoxydim, chlorazifop, clodinafop, clofop, diclofop,fenoxaprop, fenthiaprop, fluazifop, haloxyfop, isoxapyrifop, propaquizafop, quizalofop, trifop, and pinoxaden, or a derivative of any of these herbicides.

27. A method according to claim 24, wherein at least one herbicide is selected from the group consisting of sethoxydim, cycloxydim, tepraloxydim, haloxyfop, or a derivative of any of these herbicides.

28. A method for selecting herbicide-tolerant rice plants, comprising:

(a) crossing an herbicide-tolerant rice plant with other rice germplasm, and harvesting the resulting hybrid rice seed;

(b) planting the hybrid rice seed;

(c) applying one or more herbicides to the hybrid rice at levels of herbicide that would normally inhibit the growth of a rice plant, wherein at least one of the herbicides inhibits acetyl-Coenzyme A carboxylase; and

(d) harvesting seeds from the rice plants to which herbicide has been applied.

29. A method according to claim 28, wherein at least one herbicide is selected from the group consisting of aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof.

30. A method according to claim 28, wherein at least one herbicide is selected from the group consisting of alloxydim, butroxydim, caloxydim, clethodim, cloproxydim, cycloxydim, sethoxydim, tepraloxydim, tralkoxydim, chlorazifop, clodinafop, clofop, diclofop,fenoxaprop, fenthiaprop, fluazifop, haloxyfop, isoxapyrifop, propaquizafop, quizalofop, trifop, and pinoxaden, or a derivative of any of these herbicides.

31. A method according to claim 28, wherein at least one herbicide is selected from the group consisting of sethoxydim, cycloxydim, tepraloxydim, haloxyfop, or a derivative of any of these herbicides.

32. A method for growing herbicide-tolerant rice plants, comprising:

(a) planting rice seeds;

(b) allowing the rice seeds to sprout;

(c) applying one or more herbicides to the rice sprouts at levels of herbicide that would normally inhibit the growth of a rice plant, wherein at least one of the herbicides inhibits acetyl-Coenzyme A carboxylase.

33. A method according to claim 32, wherein at least one herbicide is selected from the group consisting of aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof.

34. A method according to claim 32, wherein at least one herbicide is selected from the group consisting of alloxydim, butroxydim, caloxydim, clethodim, cloproxydim, cycloxydim, sethoxydim, tepraloxydim, tralkoxydim, chlorazifop, clodinafop, clofop, diclofop,fenoxaprop, fenthiaprop, fluazifop, haloxyfop, isoxapyrifop, propaquizafop, quizalofop, trifop, and pinoxaden, or a derivative of any of these herbicides.

35. A method according to claim 32, wherein at least one herbicide is selected from the group consisting of sethoxydim, cycloxydim, tepraloxydim, haloxyfop, or a derivative of any of these herbicides.

36. A method for selecting herbicide-tolerant plants …

37. A seed of rice cultivar **Indica1**, wherein a representative sample of seed of said cultivar was deposited under ATCC Accession No. PTA-10267.

38. A rice plant, or a part thereof, produced by growing the seed of claim 37.

39. A tissue culture of cells produced from the seed of claim 37.

40. A tissue culture of cells produced from the plant of claim 38, wherein said cells of the tissue culture are produced from a plant part selected from the group consisting of leaves, pollen, embryos, cotyledons, hypocotyls, meristematic cells, roots, root tips, pistils, anthers, flowers and stems.

41. A rice plant generated from the tissue culture of any one of claims 39 or 40, wherein the plant has all the morphological and physiological characteristics of cultivar Inidica1.

42. A seed of an herbicide-tolerant rice plant, wherein a plant grown from the seed is tolerant to at least one herbicide that inhibits acetyl-Coenzyme A carboxylase activity at levels of herbicide that would normally inhibit the growth of a rice plant.

43. A seed of a rice plant, wherein a plant grown from the seed expresses an acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid sequence differs from an amino acid sequence of an acetyl-Coenzyme A carboxylase of a wild-type rice plant at one or more of

the following positions: 1,781(*Am*), 1,999(*Am*), 2,027(*Am*), 2,041(*Am*), 2,078(*Am*), 2088(*Am*) or 2,096(*Am*).

44. A seed of a rice plant, wherein a plant grown from the seed expresses an acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid sequence comprises one or more of the following: the amino acid at position 1,781(*Am*) is other than isoleucine; the amino acid at position 1,999(*Am*) is other than tryptophan; the amino acid at position 2,027(*Am*) is other than tryptophan; the amino acid at position 2,041(*Am*) is other than isoleucine; the amino acid at position 2,078(*Am*) is other than aspartate; the amino acid at position 2088(*Am*) is other than cysteine; or the amino acid at position 2,096(*Am*) is other than glycine.

45. A seed of a rice plant, wherein a plant grown from the seed expresses an acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid sequence comprises one or more of the following: the amino acid at position 1,781(*Am*) is leucine or alanine; the amino acid at position 1,999(*Am*) is cysteine; the amino acid at position 2,027(*Am*) is cysteine; the amino acid at position 2,041(*Am*) is asparagine; the amino acid at position 2,078(*Am*) is glycine; the amino acid at position 2088(*Am*) is arginine or the amino acid at position 2,096(*Am*) is alanine.

46. A method for producing rice seed, comprising:

crossing an herbicide-tolerant rice plant with other rice germplasm; and

harvesting the resulting hybrid rice seed, wherein the herbicide-tolerant rice plant is tolerant to aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof at levels of herbicide that would normally inhibit the growth of a rice plant.

47. A method for producing an F1 hybrid rice seed, comprising:

crossing an herbicide-tolerant rice plant with a different rice plant; and

harvesting the resultant F1 hybrid rice seed, wherein the herbicide-tolerant rice plant is tolerant to aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof at levels of herbicide that would normally inhibit the growth of a rice plant.

48. A method of producing an herbicide-tolerant rice plant, comprising:

transforming a cell of a rice plant with a transgene, wherein the transgene encodes an acetyl-Coenzyme A carboxylase enzyme that confers tolerance to at least one herbicide is selected from the group consisting of aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof.

49. A method according to claim 48, wherein the cell is in the form of a callus.

50. A method according to claim 48, wherein at least one herbicide is selected from the group consisting of alloxydim, butroxydim, caloxydim, clethodim, cloproxydim, cycloxydim, sethoxydim, tepraloxydim, tralkoxydim, chlorazifop, clodinafop, clofop, diclofop,fenoxaprop, fenthiaprop, fluazifop, haloxyfop, isoxapyrifop, propaquizafop, quizalofop, trifop, and pinoxaden, or a derivative of any of these herbicides.

51. A method according to claim 48, wherein at least one herbicide is selected from the group consisting of sethoxydim, cycloxydim, tepraloxydim, haloxyfop, or a derivative of any of these herbicides.

52. A method according to claim 48, wherein the transgene comprises a nucleic acid sequence encoding a protein comprising an amino acid sequence comprising one or more of a modified SEQ ID NO:2 and a modified SEQ ID NO:3, wherein the sequence is modified such that the encoded protein comprises one or more of the following: the amino acid at position 1,781(*Am*) is leucine or alanine; the amino acid at position 1,999(*Am*) is cysteine; the amino acid at position 2,027(*Am*) is cysteine; the amino acid at position 2,041(*Am*) is asparagine; the amino acid at position 2,078(*Am*) is glycine; the amino acid at position 2088(*Am*) is arginine or the amino acid at position 2,096(*Am*) is alanine.

53. An herbicide-tolerant rice plant produced by the method of claim 48.

54. A method of producing an herbicide-tolerant rice plant, comprising:

transforming a cell of a rice plant with a transgene encoding an enzyme that confers herbicide tolerance,

wherein the cell was produced from a rice plant expressing an acetyl-Coenzyme A carboxylase enzyme that confers tolerance to at least one herbicide is selected from the group consisting of aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof.

55. A method according to claim 54, wherein the cell is in the form of a callus.

56. An herbicide-tolerant rice plant produced by the method of claim 54.

57. A method of producing a recombinant rice plant, comprising:

transforming a cell of a rice plant with a transgene,

wherein the cell was produced from a rice plant expressing an acetyl-Coenzyme A carboxylase enzyme that confers tolerance to at least one herbicide is selected from the group consisting of aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof.

58. A method according to claim 57, wherein the cell is in the form of a callus.

59. The method according to claim 57, wherein the transgene encodes a protein.

60. The method according to claim 59, wherein the protein is an enzyme that modifies fatty acid metabolism and/or carbohydrate metabolism.

61. The method according to claim 57, wherein the transgene is selected from the group consisting of nucleotide sequences encoding fructosyltransferase, levansucrase, alpha-amylase, invertase and starch branching enzyme or encoding an antisense of stearyl-ACP desaturase.

62. A recombinant rice plant produced by the method of claim 57.

63. A method of producing a rice plant having a desired trait, comprising:

(a) crossing a rice plant that is tolerant to aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof at levels of herbicide that would normally inhibit the growth of a rice plant with a plant of another rice cultivar that comprises the desired trait to produce progeny plants;

(b) selecting one or more progeny plants that have the desired trait to produce selected progeny plants;

(c) crossing the selected progeny plants with the herbicide-tolerant plants to produce backcross progeny plants;

(d) selecting for backcross progeny plants that have the desired trait and herbicide tolerance; and

(e) repeating steps (c) and (d) three or more times in succession to produce selected fourth or higher backcross progeny plants that comprise the desired trait and herbicide tolerance.

64. A method according to claim 63, wherein the desired trait is selected from the group consisting of male sterility, herbicide tolerance, drought tolerance insect resistance, modified fatty acid metabolism, modified carbohydrate metabolism and resistance to bacterial disease, fungal disease or viral disease.

65. A method of producing a male sterile rice plant wherein the method comprises transforming a rice plant tolerant to at least one herbicide that inhibits acetyl-Coenzyme A carboxylase activity at levels of herbicide that would normally inhibit the growth of a rice plant with a nucleic acid molecule that confers male sterility.

66. A male sterile rice plant produced by the method of claim 65.

67. A composition, comprising:

one or more cells of a rice plant; and

an aqueous medium, wherein the medium comprises a compound that inhibits acetyl-Coenzyme A carboxylase activity, and wherein the cells are derived from a rice plant tolerant to aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides or combinations thereof at levels of herbicide that would normally inhibit the growth of a rice plant.

68. A composition according to claim 67, wherein the compound comprises one or more of aryloxyphenoxypropionate herbicides, cyclohexanedione herbicides, phenylpyrazoline herbicides and combinations thereof.

69. An isolated nucleic acid molecule encoding a rice acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid sequence differs from an amino acid sequence of an acetyl-Coenzyme A carboxylase of a wild-type rice plant at one or more of the following positions: 1,781(*Am*), 1,999(*Am*), 2,027(*Am*), 2,041(*Am*), 2,078(*Am*), 2088(*Am*) or 2,096(*Am*).

70. An isolated nucleic acid molecule encoding a rice acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid sequence comprises one or more of the following: the amino acid at position 1,781(*Am*) is other than isoleucine; the amino acid at position 1,999(*Am*) is other than tryptophan; the amino acid at position 2,027(*Am*) is other than tryptophan; the amino acid at position 2,041(*Am*) is other than isoleucine; the amino acid at

position 2,078(*Am*) is other than aspartate; the amino acid at position 2088(*Am*) is other than cysteine; or the amino acid at position 2,096(*Am*) is other than glycine.

71. An isolated nucleic acid molecule encoding a rice acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid sequence comprises one or more of the following: the amino acid at position 1,781(*Am*) is leucine or alanine; the amino acid at position 1,999(*Am*) is cysteine; the amino acid at position 2,027(*Am*) is cysteine; the amino acid at position 2,041(*Am*) is asparagine; the amino acid at position 2,078(*Am*) is glycine; the amino acid at position 2088(Am) is Arginine or the amino acid at position 2,096(*Am*) is alanine.

72. An isolated nucleic acid molecule encoding a protein comprising SEQ ID NO:XX.

73. An herbicide-tolerant, BEP clade plant having increased tolerance to an ACCase-inhibitor (ACCI) as compared to a wild-type variety of the plant, wherein the herbicide-tolerant plant is produced by a process comprising either:

(I) the steps of

(a) providing BEP clade plant cells having a first, zero or non-zero level of ACCI tolerance;

(b) growing the cells in contact with a medium to form a cell culture;

(c) contacting cells of said culture with an ACCI;

(d) growing ACCI-contacted cells from step (c) to form a culture containing cells having a level of ACCI tolerance greater than the first level of step (a); and

(e) generating, from ACCI-tolerant cells of step (d), a plant having a level of ACCI tolerance greater than that of a wild-type variety of the plant; or

(II) the steps of

(f) providing a first, herbicide-tolerant, BEP clade plant having increased tolerance to an ACCase-inhibitor (ACCI) as compared to a wild-type variety of the plant, said herbicide-tolerant plant having been produced by a process comprising steps (a)-(e); and

(g) producing from the first plant a second, herbicide-tolerant, BEP clade plant that retains the increased herbicide tolerance characteristics of the first plant;

thereby obtaining an herbicide-tolerant, BEP clade plant.

74. An herbicide-tolerant plant according to claim 73, wherein said plant is a member of the Bambusoideae - Ehrhartoideae subclade.

75. An herbicide-tolerant plant according to claim 73, wherein said plant is a member of the subfamily Ehrhartoideae.

76. An herbicide-tolerant plant according to claim 73, wherein the cells are in the form of a callus.

77. An herbicide-tolerant plant according to claim 73, wherein said plant is a member of the genus *Oryza.*

78. An herbicide-tolerant plant according to claim 73, wherein said plant is a member of the species *O. sativa.*

79. An herbicide-tolerant plant according to claim 73, wherein the medium does not comprise a mutagen.

80. An herbicide-tolerant plant according to claim 73, wherein said herbicide-tolerant plant expresses an acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid sequence differs from an amino acid sequence of an acetyl-Coenzyme A carboxylase of a corresponding wild-type BEP clade plant at one or more of the following positions: 1,781(*Am*), 1,999(*Am*), 2,027(*Am*), 2,041(*Am*), 2,078(*Am*), 2088(*Am*) or 2,096(*Am*).

81. An herbicide-tolerant plant according to claim 73, wherein said herbicide-tolerant plant expresses an acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid sequence comprises one or more of the following: the amino acid at position 1,781(*Am*) is other than isoleucine; the amino acid at position 1,999(*Am*) is other than tryptophan; the amino acid at position 2,027(*Am*) is other than tryptophan; the amino acid at position 2,041(*Am*) is other than isoleucine; the amino acid at position 2,078(*Am*) is other than aspartate; the amino acid at position 2088(*Am*) is other than cysteine; or the amino acid at position 2,096(*Am*) is other than glycine.

82. An herbicide-tolerant plant according to claim 73, wherein said herbicide-tolerant plant expresses an acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid sequence comprises one or more of the following: the amino acid at position 1,781(*Am*) is leucine or alanine; the amino acid at position 1,999(*Am*) is cysteine; the amino acid at position 2,027(*Am*) is cysteine; the amino acid at position 2,041(*Am*) is asparagine; the amino acid at position 2,078(*Am*) is glycine; the amino acid at position 2088(*Am*) is arginine or the amino acid at position 2,096(*Am*) is alanine.

83. An herbicide-tolerant plant, wherein said plant is produced by the process of:

(a) crossing or back-crossing a plant grown from a seed of a plant according to claim 73 with other germplasm;

(b) growing the plants resulting from said crossing or back-crossing in the presence of at least one herbicide that normally inhibits acetyl-Coenzyme A carboxylase, at levels of the herbicide that would normally inhibit the growth of a plant; and

(c) selecting for further propagation plants resulting from said crossing or back-crossing, wherein the plants selected are plants that grow without significant injury in the presence of the herbicide.

84. An isolated nucleic acid molecule comprising a nucleotide sequence encoding a mutagenized acetyl-Coenzyme A carboxylase of a plant in the BEP clade of the Family Poaceae, in which the amino acid sequence of the mutagenized acetyl-Coenzyme A carboxylase differs from an amino acid sequence of an acetyl-Coenzyme A carboxylase of the corresponding wild-type plant at one or more of the following positions: 1,781(*Am*), 1,999(*Am*), 2,027(*Am*), 2,041(*Am*), 2,078(*Am*), 2088(*Am*) or 2,096(*Am*).

85. A nucleic acid according to claim 84, wherein the nucleic acid has been isolated from a plant by a process comprising either:

(I) the steps of

(a) providing BEP clade plant cells having a first, zero or non-zero level of ACCase-inhibitor (ACCI) tolerance;

(b) growing the cells in contact with a medium to form a cell culture;

(c) contacting cells of said culture with an ACCI;

(d) growing ACCI-contacted cells from step (c) to form a culture containing cells having a level of ACCI tolerance greater than the first level of step (a); and

(e) generating, from ACCI-tolerant cells of step (d), a plant having a level of ACCI tolerance greater than that of a wild-type variety of the plant; or

(II) the steps of

(f) providing a first, herbicide-tolerant, BEP clade plant having increased tolerance to an ACCase-inhibitor (ACCI) as compared to a wild-type variety of the plant, said herbicide-tolerant plant having been produced by a process comprising steps (a)-(e); and

(g) producing from the first plant a second, herbicide-tolerant, BEP clade plant that retains the increased herbicide tolerance characteristics of the first plant;

thereby obtaining an herbicide-tolerant, BEP clade plant; and
isolating a nucleic acid from the herbicide-tolerant BEP clade plant.

86. A rice plant according to claim 4, wherein said plant expresses an acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid the amino acid at position 1,781(*Am*) is leucine or alanine and at least one of the following: the amino acid at position 2,027(*Am*) is cysteine; the amino acid at position 2,041(*Am*) is asparagine; or the amino acid at position 2,096(*Am*) is alanine.

87. A rice plant according to claim 86, plant expresses an acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid the amino acid at position 2,027(*Am*) is cysteine.

88. A rice plant according to claim 86, plant expresses an acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid the amino acid at position 2,041(*Am*) is asparagine.

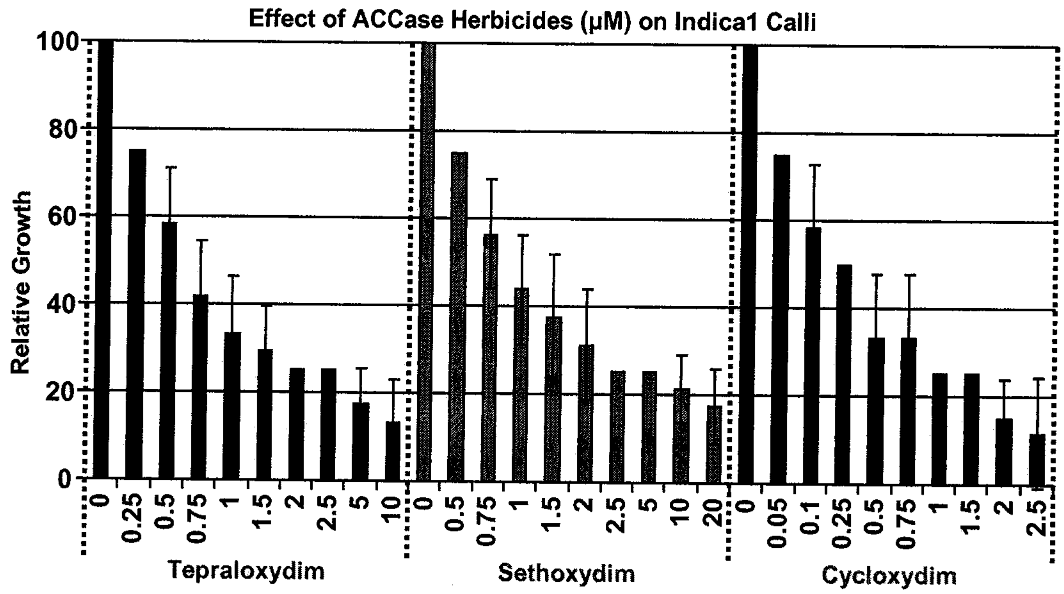
89. A rice plant according to claim 86, plant expresses an acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid the amino acid at position 2,096(*Am*) is alanine.

90. A rice plant according to claim 86, plant expresses an acetyl-Coenzyme A carboxylase (ACCase) in which the amino acid the amino acid at position 2,027(*Am*) is cysteine and the amino acid the amino acid at position 2,041(*Am*) is asparagine.

ABSTRACT OF THE DISCLOSURE

The present invention provides herbicide-tolerant plants. The present invention also provides methods for controlling the growth of weeds by applying an herbicide to which herbicide-tolerant plants of the invention are tolerant. Plants of the invention may express an acetyl-Coenzyme A carboxylase enzyme that is tolerant to the action of acetyl-Coenzyme A carboxylase enzyme inhibitors.

FIGURE 1


Effect of ACCase Herbicides (μM) on Indica1 Calli
Relative Growth
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80
60
40
20
0
0
0.25
0.5
0.75
1
1.5
2
2.5
5
10
0
0.5
0.75
1
1.5
2
2.5
5
10
20
0
0.05
0.1
0.25
0.5
0.75
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1.5
2
2.5
Tepraloxydim
Sethoxydim
Cycloxydim

FIGURE 2

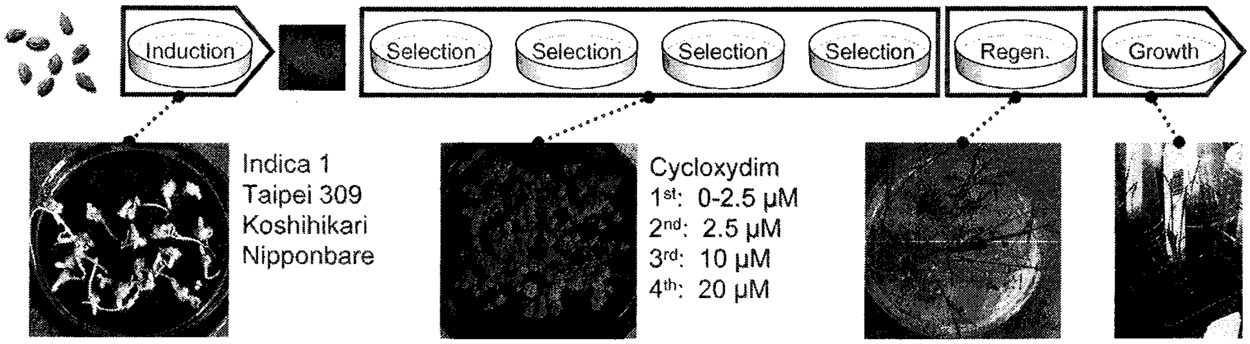

Induction
Selection
Selection
Selection
Selection
Regen.
Growth
Indica 1
Taipei 309
Koshihikari
Nipponbare
Cycloxydim
1st: 0-2.5 μM
2nd: 2.5 μM
3rd: 10 μM
4th: 20 μM

FIGURE 3

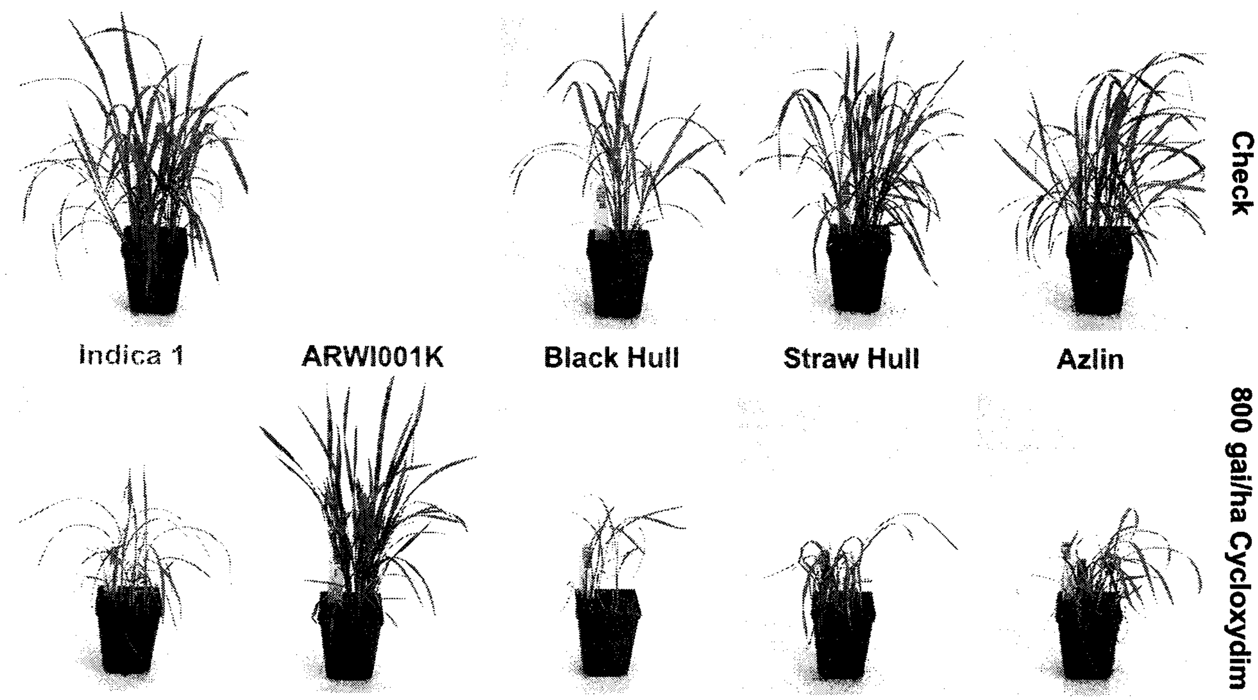
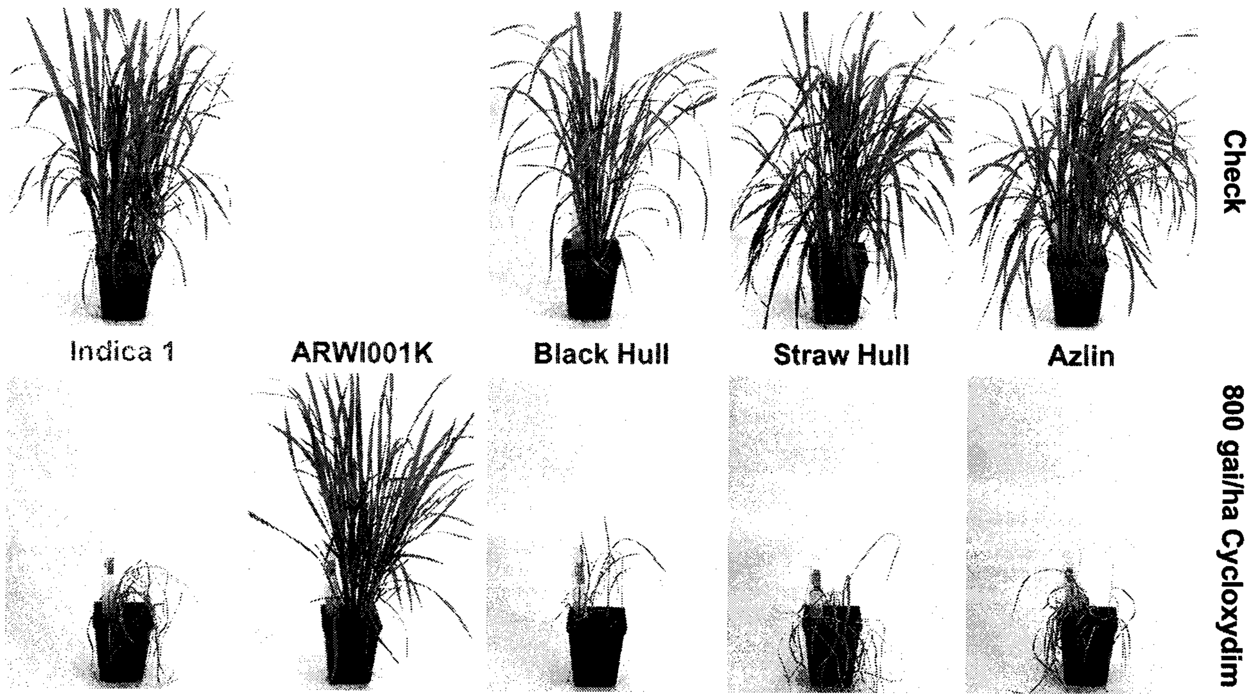

Check
Indica 1
ARWI001K
Black Hull
Straw Hull
Azlin
800 gai/ha Cycloxydim

FIGURE 4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ARWI001K
Black Hull
Straw Hull
Azlin
800 gai/ha Cycloxydim

FIGURE 5

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2006
DEFINITION  acetyl-coenzyme A carboxylase [Alopecurus myosuroides].
ACCESSION   CAC84161
VERSION     CAC84161.1  GI:20975574
DBSOURCE    embl accession AJ310767.1
KEYWORDS    .
SOURCE      Alopecurus myosuroides
  ORGANISM  Alopecurus myosuroides
            Eukaryota; Viridiplantae; Streptophyta; Embryophyta;
Tracheophyta;
            Spermatophyta; Magnoliophyta; Liliopsida; Poales; Poaceae; BEP
            clade; Pooideae; Aveneae; Alopecurus.
REFERENCE   1
  AUTHORS   Delye,C., Matejicek,A. and Gasquez,J.
  TITLE     PCR-based detection of resistance to acetyl-CoA
            carboxylase-inhibiting herbicides in black-grass (Alopecurus
            myosuroides Huds) and ryegrass (Lolium rigidum gaud)
  JOURNAL   Pest Manag. Sci. 58 (5), 474-478 (2002)
   PUBMED   11997974
REFERENCE   2
  AUTHORS   Delye,C., Calmes,E. and Matejicek,A.
  TITLE     SNP markers for black-grass (Alopecurus myosuroides Huds.)
            genotypes resistant to acetyl CoA-carboxylase inhibiting
herbicides
  JOURNAL   Theor. Appl. Genet. 104 (6-7), 1114-1120 (2002)
   PUBMED   12582620
REFERENCE   3
  AUTHORS   Delye,C., Zhang,X.Q., Chalopin,C., Michel,S. and Powles,S.B.
  TITLE     An isoleucine residue within the carboxyl-transferase domain of
            multidomain acetyl-coenzyme A carboxylase is a major determinant
of

            sensitivity to aryloxyphenoxypropionate but not to
cyclohexanedione
            inhibitors
  JOURNAL   Plant Physiol. 132 (3), 1716-1723 (2003)
   PUBMED   12857850
REFERENCE   4
  AUTHORS   Delye,C., Straub,C., Michel,S. and Le Corre,V.
  TITLE     Nucleotide variability at the acetyl coenzyme A carboxylase gene
            and the signature of herbicide selection in the grass weed
            Alopecurus myosuroides (Huds.)
  JOURNAL   Mol. Biol. Evol. 21 (5), 884-892 (2004)
   PUBMED   15014166
REFERENCE   5
  AUTHORS   Delye,C., Zhang,X.Q., Michel,S., Matejicek,A. and Powles,S.B.
  TITLE     Molecular bases for sensitivity to acetyl-coenzyme A carboxylase
            inhibitors in black-grass
  JOURNAL   Plant Physiol. 137 (3), 794-806 (2005)
   PUBMED   15579665
REFERENCE   6  (residues 1 to 2320)
  AUTHORS   Delye,C.
  TITLE     Direct Submission
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  JOURNAL   Submitted (18-JUN-2001) Delye C., Malherbologie et Agronomie,
            Institut National de la Recherche Agronomique, B. P. 86510, 21035
            Dijon cedex, FRANCE
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                     glutamine or ammonia and bicarbonate; pfam00289"
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committed

                     step in fatty acid synthesis in animals, plants and
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biotin

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                     /note="Carboxyl transferase domain. All of the members
in
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                     molecule; pfam01039"
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FIGURE 6

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NOV-2006
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VERSION     AJ310767.1  GI:20975573
KEYWORDS    acetyl-coenzyme A carboxylase.
SOURCE      Alopecurus myosuroides
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            clade; Pooideae; Aveneae; Alopecurus.
REFERENCE   1
  AUTHORS   Delye,C., Matejicek,A. and Gasquez,J.
  TITLE     PCR-based detection of resistance to acetyl-CoA
            carboxylase-inhibiting herbicides in black-grass (Alopecurus
            myosuroides Huds) and ryegrass (Lolium rigidum gaud)
  JOURNAL   Pest Manag. Sci. 58 (5), 474-478 (2002)
   PUBMED   11997974
REFERENCE   2
  AUTHORS   Delye,C., Calmes,E. and Matejicek,A.
  TITLE     SNP markers for black-grass (Alopecurus myosuroides Huds.)
            genotypes resistant to acetyl CoA-carboxylase inhibiting
herbicides
  JOURNAL   Theor. Appl. Genet. 104 (6-7), 1114-1120 (2002)
   PUBMED   12582620
REFERENCE   3
  AUTHORS   Delye,C., Zhang,X.Q., Chalopin,C., Michel,S. and Powles,S.B.
  TITLE     An isoleucine residue within the carboxyl-transferase domain
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            multidomain acetyl-coenzyme A carboxylase is a major
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            inhibitors
  JOURNAL   Plant Physiol. 132 (3), 1716-1723 (2003)
   PUBMED   12857850
REFERENCE   4
  AUTHORS   Delye,C., Straub,C., Michel,S. and Le Corre,V.
  TITLE     Nucleotide variability at the acetyl coenzyme A carboxylase
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            and the signature of herbicide selection in the grass weed
            Alopecurus myosuroides (Huds.)
  JOURNAL   Mol. Biol. Evol. 21 (5), 884-892 (2004)
   PUBMED   15014166
REFERENCE   5
  AUTHORS   Delye,C., Zhang,X.Q., Michel,S., Matejicek,A. and Powles,S.B.
  TITLE     Molecular bases for sensitivity to acetyl-coenzyme A
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  JOURNAL   Plant Physiol. 137 (3), 794-806 (2005)
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   PUBMED   15579665
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  AUTHORS   Delye,C.
  TITLE     Direct Submission
  JOURNAL   Submitted (18-JUN-2001) Delye C., Malherbologie et Agronomie,
            Institut National de la Recherche Agronomique, B. P. 86510,
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            Dijon cedex, FRANCE
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4681 aatacttcgt atcagccttt gagtgttatt gatttaaaac gttgctctgc caggaacaac
4741 aaaactacat actgctatga ttttccattg acatttgaag ctgcagtgca gaagtcgtgg
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4981 cagatcattg ttatcgcaaa tgatattaca tttagagctg gatcatttgg cccaagggaa
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5341 atacatggaa gtgctgctat tgccagtgcc tattctaggg cgtacgagga gacatttaca
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5761 atcagtggca ttgatgacag ccaagggaaa tggttgggtg gcatgtttga caaagacagt
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6361 cttgatccag aattgataga tctgaaagca agactccagg gagcaaatgg aagcctatct
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6481 acccaaatcg cggtacgttt tgcggaattg cacgacactt cccttagaat ggctgctaaa
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6601 cggaggaggc tatccgagga cgttctggca aaggagatta gaggtgtaat tggtgagaag
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6841 gatgttgcag gctccagttc ggatttacaa gccttgccgc agggtctttc catgctacta
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6961 tga
//

FIGURE 7A

>OsI.ACCI [BGIOSIBCE018385]
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aagtctttcagattccagctcagatttgcaagccctgccacagggtctttccatgttactagataagatg
gatccctctagaagagctcaacttgttgaagaaatcaggaaggtccttggttga

FIGURE 7B

>OsI.ACCI [BGIOSIBCE018385]
MTSTHVATLGVGAQAPPRHQKKSAGTAFVSSGSSRPSYRKNGQRTRSLREESNGGVSDSKKLNHSIRQGL
AGIIDLPNDAASEVDISHGSEDPRGPTVPGSYQMNGIINETHNGRHASVSKVVEFCTALGGKTPIHSVLV
ANNGMAAAKFMRSVRTWANDTFGSEKAIQLIAMATPEDLRINAEHIRIADQFVEVPGGTNNNNYANVQLI
VEIAERTGVSAVWPGWGHASENPELPDALTAKGIVFLGPPASSMHALGDKVGSALIAQAAGVPTLAWSGS
HVEVPLECCLDSIPDEMYRKACVTTTEEAVASCQVVGYPAMIKASWGGGGKGIRKVHNDDEVRTLFKQVQ
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RFYGMNHGGGYDLWRKTAALATPFNFDEVDSKWPKGHCVAVRITSEDPDDGFKPTGGKVKEISFKSKPNV
WAYFSVKSGGGIHEFADSQFGHVFAYGTTRSAAITTMALALKEVQIRGEIHSNVDYTVDLLNASDFRENK
IHTGWLDTRIAMRVQAERPPWYISVVGGALYKTVTANTATVSDYVGYLTKGQIPPKHISLVYTTVALNID
GKKYTIDTVRSGHGSYRLRMNGSTVDANVQILCDGGLLMQLDGNSHVIYAEEEASGTRLLIDGKTCMLQN
DHDPSKLLAETPCKLLRFLVADGAHVDADVPYAEVEVMKMCMPLLSPASGVIHVVMSEGQAMQAGDLIAR
LDLDDPSAVKRAEPFEDTFPQMGLPIAASGQVHKLCAASLNACRMILAGYEHDIDKVVPELVYCLDTPEL
PFLQWEELMSVLATRLPRNLKSELEGKYEEYKVKFDSGIINDFPANMLRVIIEENLACGSEKEKATNERL
VEPLMSLLKSYEGGRESHAHFVVKSLFEEYLYVEELFSDGIQSDVIERLRLQHSKDLQKVVDIVLSHQSV
RNKTKLILKLMESLVYPNPAAYRDQLIRFSSLNHKAYYKLALKASELLEQTKLSELRARIARSLSELEMF
TEESKGLSMHKREIAIKESMEDLVTAPLPVEDALISLFDCSDTTVQQRVIETYIARLYQPHLVKDSIKMK
WIESGVIALWEFPEGHFDARNGGAVLGDKRWGAMVIVKSLESLSMAIRFALKETSHYTSSEGNMMHIALL
GADNKMHIIQESGDDADRIAKLPLILKDNVTDLHASGVKTISFIVQRDEARMTMRRTFLWSDEKLSYEEE
PILRHVEPPLSALLELDKLKVKGYNEMKYTPSRDRQWHIYTLRNTENPKMLHRVFFRTLVRQPSVSNKFS
SGQIGDMEVGSAEEPLSFTSTSILRSLMTAIEELELHAIRTGHSHMYLHVLKEQKLLDLVPVSGNTVLDV
GQDEATAYSLLKEMAMKIHELVGARMHHLSVCQWEVKLKLDCDGPASGTWRIVTTNVTSHTCTVDIYREM
EDKESRKLVYHPATPAAGPLHGVALNNPYQPLSVIDLKRCSARNNRTTYCYDFPLAFETAVRKSWSSSTS
GASKGVENAQCYVKATELVFADKHGSWGTPLVQMDRPAGLNDIGMVAWTLKMSTPEFPSGREIIVVANDI
TFRAGSFGPREDAFFEAVTNLACEKKLPLIYLAANSGARIGIADEVKSCFRVGWSDDGSPERGFQYIYLS
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LYTQIAIRFAELHDTSLRMAAKGVIKKVVDWEESRSFFYKRLRRRISEDVLAKEIRAVAGEQFSHQPAIE
LIKKWYSASHAAEWDDDDAFVAWMDNPENYKDYIQYLKAQRVSQSLSSLSDSSSDLQALPQGLSMLLDKM
DPSRRAQLVEEIRKVLG

FIGURE 8A

>OsJ.ACCI [Os05g22940]
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FIGURE 8B

>OsjACCI [EAZ33685]
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WIESGVIALWEFPEGHFDARNGGAVLGDKRWGAMVIVKSLESLSMAIRFALKETSHYTSSEGNMMHIALL
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PILRHVEPPLSALLELDKLKVKGYNEMKYTPSRDRQWHIYTLRNTENPKMLHRVFFRTLVRQPSVSNKFS
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KVLG

FIGURE 9A

>AY312172_Zea mays

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FIGURE 9B

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HGVALNNPYQPLSVIDLKRCSARNNRTTYCYDFPLAFETALQKSWQSNGSTVSEGNEN
SKSYVKATELVFAEKHGSWGTPIIPMERPAGLNDIGMVAWIMEMSTPEFPNGRQIIVV
ANDITFRAGSFGPREDAFFETVTNLACERKLPLIYLAANSGARIGIADEVKSCFRVGW
SDEGSPERGFQYIYLTEEDYARISSSVIAHKLELDSGEIRWIIDSVVGKEDGLGVENI
HGSAAIASAYSRAYEETFTLTFVTGRTVGIGAYLARLGIRCIQRLDQPIILTGFSALN
KLLGREVYSSHMQLGGPKIMATNGVVHLTVPDDLEGVSNILRWLSYVPANIGGPLPIT
KPLDPPDRPVAYIPENTCDPRAAICGVDDSQGKWLGGMFDKDSFVETFEGWAKTVVTG
RAKLGGIPVGVIAVETQTMMQIIPADPGQLDSHERSVPRAGQVWFPDSATKTAQALLD
FNREGLPLFILANWRGFSGGQRDLFEGILQAGSTIVENLRTSNQPAFVYIPMAGELRG
GAWVVVDSKINPDRIECYAERTAKGNVLEPQGLIEIKFRSEELQDCMGRLDPELINLK
AKLQDVNHGNGSLPDIEGIRKSIEARTKQLLPLYTQIAIRFAELHDTSLRMAAKGVIK
KVVDWEESRSFFYKRLRRRIAEDVLAKEIRQIVGDKFTHQLAMELIKEWYLASQATTG
STGWDDDDAFVAWKDSPENYKGHIQKLRAQKVSHSLSDLADSSSDLQAFSQGLSTLLD
KMDPSQRAKFVQEVKKVLD

FIGURE 10A

>AY312171_Zea mays
ATGTCACAGCTTGGATTAGCCGCAGCTGCCTCAAAGGCCTTGCCACTACTCCCTAATCGCCAGAGAAGTT
CAGCTGGGACTACATTCTCATCATCTTCATTATCGAGGCCCTTAAACAGAAGGAAAAGCCGTACTCGTTC
ACTCCGTGATGGCGGAGATGGGGTATCAGATGCCAAAAAGCACAGCCAGTCTGTTCGTCAAGGTCTTGCT
GGCATTATCGACCTCCCAAGTGAGGCACCTTCCGAAGTGGATATTTCACATGGATCTGAGGATCCTAGGG
GGCCAACAGATTCTTATCAAATGAATGGGATTATCAATGAAACACATAATGGAAGACATGCCTCAGTGTC
CAAGGTTGTTGAATTTTGTGCGGCACTAGGTGGCAAAACACCAATTCACAGTATATTAGTGGCCAACAAT
GGAATGGCAGCAGCAAAATTTATGAGGAGTGTCCGGACATGGGCTAATGATACTTTTGGATCTGAGAAGG
CAATTCAACTCATAGCTATGGCAACTCCGGAAGACATGAGGATAAATGCAGAACACATTAGAATTGCTGA
CCAATTCGTAGAGGTGCCTGGTGGAACAAACAATAATAACTACGCCAATGTTCAACTCATAGTGGAGATG
GCACAAAAACTAGGTGTTTCTGCTGTTTGGCCTGGTTGGGGTCATGCTTCTGAGAATCCTGAACTGCCAG
ATGCATTGACCGCAAAAGGGATCGTTTTTCTTGGCCCACCTGCATCATCAATGAATGCTTTGGGAGATAA
GGTCGGCTCAGCTCTCATTGCTCAAGCAGCCGGGGTCCCAACTCTTGCTTGGAGTGGATCACATGTTGAA
GTTCCATTAGAGTGCTGCTTAGACGCGATACCTGAGGAGATGTATAGAAAAGCTTGCGTTACTACCACAG
AGGAAGCAGTTGCAAGTTGTCAAGTGGTTGGTTATCCTGCCATGATTAAGGCATCCTGGGGAGGTGGTGG
TAAAGGAATAAGAAAGGTTCATAATGATGATGAGGTTAGAGCGCTGTTTAAGCAAGTACAAGGTGAAGTC
CCTGGCTCCCCAATATTTGTCATGAGGCTTGCATCCCAGAGTCGGCATCTTGAAGTTCAGTTGCTTTGTG
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GCTAAGGCTGTGGGTTATGTTGGTGCTGCTACTGTTGAGTATCTTTACAGCATGGAAACTGGAGACTACT
ATTTTCTGGAACTTAATCCCCGACTACAGGTTGAGCATCCAGTCACCGAGTGGATAGCTGAAGTAAATCT
GCCTGCAGCTCAAGTTGCTGTTGGAATGGGCATACCTCTTTGGCAGATTCCAGAAATCAGACGTTTCTAT
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TTCTCAGTAAAGTCTGGTGGAGGCATTCATGAATTTGCTGATTCTCAGTTCGGACATGTTTTTGCATATG
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GGGCCAGATTCCACCAAAGCATATATCCCTTGTCAATTCTACAGTTAATTTGAATATAGAAGGGAGCAAA
TACACAATTGAAACTGTAAGGACTGGACATGGTAGCTACAGGTTGAGAATGAATGATTCAACAGTTGAAG
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TGTCATTCATTGTATGATGTCTGAGGGCCAGGCATTGCAGGCTGGTGATCTTATAGCAAGGTTGGATCTT
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TGAGCACAATATTAATGAAGTCGTTCAAGATTTGGTATGCTGCCTGGACAACCCTGAGCTTCCTTTCCTA
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CATCATTGAGGAAAATCTTTCTTATGGTTCAGAGAAGGAAAAGGCTACAAATGAGAGGCTTGTTGAGCCT
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TCGAGGAGTATCTTACAGTGGAAGAACTTTTTAGTGATGGCATTCAGTCTGACGTGATTGAAACATTGCG
GCATCAGCACAGTAAAGACCTGCAGAAGGTTGTAGACATTGTGTTGTCTCACCAGGGTGTGAGGAACAAA
GCTAAGCTTGTAACGGCACTTATGGAAAAGCTGGTTTATCCAAATCCTGGTGGTTACAGGGATCTGTTAG
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AACCAAACTAAGTGAACTCCGTGCAAGCGTTGCAAGAAGCCTTTCGGATCTGGGGATGCATAAGGGAGAA
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TGTTTGATTACAGTGATCGAACTGTTCAGCAGAAAGTGATTGAGACATACATATCACGATTGTACCAGCC
TCATCTTGTAAAGGATAGCATCCAAATGAAATTCAAGGAATCTGGTGCTATTACTTTTTGGGAATTTTAT
GAAGGGCATGTTGATACTAGAAATGGACATGGGGCTATTATTGGTGGGAAGCGATGGGGTGCCATGGTCG
TTCTCAAATCACTTGAATCTGCGTCAACAGCCATTGTGGCTGCATTAAAGGATTCGGCACAGTTCAACAG
CTCTGAGGGCAACATGATGCACATTGCATTATTGAGTGCTGAAAATGAAAGTAATATAAGTGGAATAAGT

GATGATCAAGCTCAACATAAGATGGAAAAGCTTAGCAAGATACTGAAGGATACTAGCGTTGCAAGTGATC
TCCAAGCTGCTGGTTTGAAGGTTATAAGTTGCATTGTTCAAAGAGATGAAGCTCGCATGCCAATGCGCCA
CACATTCCTCTGGTTGGATGACAAGAGTTGTTATGAAGAAGAGCAGATTCTCCGGCATGTGGAGCCTCCC
CTCTCTACACTTCTTGAATTGGATAAGTTGAAGGTGAAAGGATACAATGAAATGAAGTATACTCCTTCGC
GTGACCGCCAATGGCATATCTACACACTAAGAAATACTGAAAACCCCAAAATGTTGCATAGGGTGTTTTT
CCGAACTATTGTCAGGCAACCCAATGCAGGCAACAAGTTTACATCGGCTCAGATCAGCGACGCTGAAGTA
GGATGTCCCGAAGAATCTCTTTCATTTACATCAAATAGCATCTTAAGATCATTGATGACTGCTATTGAAG
AATTAGAGCTTCATGCAATTAGGACAGGTCATTCTCACATGTATTTGTGCATACTGAAAGAGCAAAAGCT
TCTTGACCTCATTCCATTTTCAGGGAGTACAATTGTTGATGTTGGCCAAGATGAAGCTACCGCTTGTTCA
CTTTTAAAATCAATGGCTTTGAAGATACATGAGCTTGTTGGTGCAAGGATGCATCATCTGTCTGTATGCC
AGTGGGAGGTGAAACTCAAGTTGGACTGTGATGGCCCTGCAAGTGGTACCTGGAGAGTTGTAACTACAAA
TGTTACTGGTCACACCTGCACCATTGATATATACCGAGAAGTGGAGGAAATAGAATCGCAGAAGTTAGTG
TACCATTCAGCCACTTCGTCAGCTGGACCATTGCATGGTGTTGCACTGAATAATCCATATCAACCTTTGA
GTGTGATTGATCTAAAGCGCTGCTCTGCTAGGAACAACAGAACAACATATTGCTATGATTTTCCGCTGGC
CTTTGAAACTGCACTGCAGAAGTCATGGCAGACCAATGGCTCTACTGTTTCTGAAGGCAATGAAAATAGT
AAATCCTACGTGAAGGCAACTGAGCTAGTGTTTGCTGAAAAACATGGGTCCTGGGGCACTCCTATAATTC
CGATGGAACGCCCTGCTGGGCTCAACGACATTGGTATGGTCGCTTGGATCATGGAGATGTCAACACCTGA
ATTTCCCAATGGCAGGCAGATTATTGTTGTAGCAAATGATATCACTTTCAGAGCTGGATCATTTGGCCCA
AGGGAAGATGCATTTTTTGAAACTGTCACTAACCTGGCTTGCGAAAGGAAACTTCCTCTTATATACTTGG
CAGCAAACTCTGGTGCTAGGATTGGCATAGCTGATGAAGTAAAATCTTGCTTCCGTGTTGGATGGTCTGA
CGAAGGCAGTCCTGAACGAGGGTTTCAGTACATCTATCTGACTGAAGAAGACTATGCTCGCATTAGCTCT
TCTGTTATAGCACATAAGCTGGAGCTAGATAGTGGTGAAATTAGGTGGATTATTGACTCTGTTGTGGGCA
AGGAGGATGGGCTTGGTGTCGAGAACATACATGGAAGTGCTGCTATTGCCAGTGCTTATTCTAGGGCATA
TGAGGAGACATTTACACTTACATTTGTGACTGGGCGGACTGTAGGAATAGGAGCTTATCTTGCTCGACTT
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TTGGGCGGGAAGTGTACAGCTCCCACATGCAGCTTGGTGGTCCTAAGATCATGGCGACTAATGGTGTTGT
CCACCTCACTGTTCCAGATGACCTTGAAGGTGTTTCCAATATATTGAGGTGGCTCAGCTATGTTCCTGCA
AACATTGGTGGACCTCTTCCTATTACCAAACCTCTGGACCCTCCAGACAGACCTGTTGCTTACATCCCTG
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GTTTGACAAAGACAGCTTTGTGGAGACATTTGAAGGATGGGCAAAAACAGTGGTTACTGGCAGAGCAAAG
CTTGGAGGAATTCCTGTGGGCGTCATAGCTGTGGAGACACAGACCATGATGCAGATCATCCCTGCTGATC
CAGGTCAGCTTGATTCCCATGAGCGATCTGTCCCTCGTGCTGGACAAGTGTGGTTCCCAGATTCTGCAAC
CAAGACCGCTCAGGCATTATTAGACTTCAACCGTGAAGGATTGCCTCTGTTCATCCTGGCTAATTGGAGA
GGCTTCTCTGGTGGACAAAGAGATCTCTTTGAAGGAATTCTTCAGGCTGGGTCAACAATTGTCGAGAACC
TTAGGACATATAATCAGCCTGCTTTTGTGTACATTCCTATGGCTGGAGAGCTTCGTGGAGGAGCTTGGGT
TGTGGTCGATAGCAAAATAAATCCAGACCGCATTGAGTGTTATGCTGAAAGGACTGCCAAAGGTAATGTT
CTCGAACCTCAAGGGTTAATTGAAATCAAGTTCAGGTCAGAGGAACTCCAAGACTGTATGGGTAGGCTTG
ACCCAGAGTTGATAAATCTGAAAGCAAAACTCCAAGATGTAAATCATGGAAATGGAAGTCTACCAGACAT
AGAAGGGATTCGGAAGAGTATAGAAGCACGTACGAAACAGTTGCTGCCTTTATATACCCAGATTGCAATA
CGGTTTGCTGAATTGCATGATACTTCCCTAAGAATGGCAGCTAAAGGTGTGATTAAGAAAGTTGTAGACT
GGGAAGAATCACGCTCGTTCTTCTATAAAAGGCTACGGAGGAGGATCGCAGAAGATGTTCTTGCAAAAGA
AATAAGGCAGATAGTCGGTGATAAATTTACGCACCAATTAGCAATGGAGCTCATCAAGGAATGGTACCTT
GCTTCTCAGGCCACAACAGGAAGCACTGGATGGGATGACGATGATGCTTTTGTTGCCTGGAAGGACAGTC
CTGAAAACTACAAGGGGCATATCCAAAAGCTTAGGGCTCAAAAAGTGTCTCATTCGCTCTCTGATCTTGC
TGACTCCAGTTCAGATCTGCAAGCATTCTCGCAGGGTCTTTCTACGCTATTAGATAAGATGGATCCCTCT
CAGAGAGCGAAGTTTGTTCAGGAAGTCAAGAAGGTCCTTGATTGA

FIGURE 10B

>AAP78896_Zea mays
MSQLGLAAAASKALPLLPNRQRSSAGTTFSSSSLSRPLNRRKSR
TRSLRDGGDGVSDAKKHSQSVRQGLAGIIDLPSEAPSEVDISHGSEDPRGPTDSYQMN
GIINETHNGRHASVSKVVEFCAALGGKTPIHSILVANNGMAAAKFMRSVRTWANDTFG
SEKAIQLIAMATPEDMRINAEHIRIADQFVEVPGGTNNNNYANVQLIVEMAQKLGVSA
VWPGWGHASENPELPDALTAKGIVFLGPPASSMNALGDKVGSALIAQAAGVPTLAWSG
SHVEVPLECCLDAIPEEMYRKACVTTTEEAVASCQVVGYPAMIKASWGGGGKGIRKVH
NDDEVRALFKQVQGEVPGSPIFVMRLASQSRHLEVQLLCDQYGNVAALHSRDCSVQRR
HQKIIEEGPVTVAPRETVKALEQAARRLAKAVGYVGAATVEYLYSMETGDYYFLELNP
RLQVEHPVTEWIAEVNLPAAQVAVGMGIPLWQIPEIRRFYGMDYGGGYDIWRKTAALA
TPFNFDEVDSQWPKGHCVAVRITSEDPDDGFKPTGGKVKEISFKSKPNVWAYFSVKSG
GGIHEFADSQFGHVFAYGLSRSAAITNMTLALKEIQIRGEIHSNVDYTVDLLNASDFR
ENKIHTGWLDTRIAMRVQAERPPWYISVVGGALYKTVTTNAATVSEYVSYLTKGQIPP
KHISLVNSTVNLNIEGSKYTIETVRTGHGSYRLRMNDSTVEANVQSLCDGGLLMQLDG
NSHVIYAEEEAGGTRLQIDGKTCLLQNDHDPSKLLAETPCKLLRFLVADGAHVDADVP
YAEVEVMKMCMPLLSPASGVIHCMMSEGQALQAGDLIARLDLDDPSAVKRAEPFDGIF
PQMELPVAVSSQVHKRYAASLNAARMVLAGYEHNINEVVQDLVCCLDNPELPFLQWDE
LMSVLATRLPRNLKSELEDKYKEYKLNFYHGKNEDFPSKLLRDIIEENLSYGSEKEKA
TNERLVEPLMNLLKSYEGGRESHAHFVVKSLFEEYLTVEELFSDGIQSDVIETLRHQH
SKDLQKVVDIVLSHQGVRNKAKLVTALMEKLVYPNPGGYRDLLVRFSSLNHKRYYKLA
LKASELLEQTKLSELRASVARSLSDLGMHKGEMSIKDNMEDLVSAPLPVEDALISLFD
YSDRTVQQKVIETYISRLYQPHLVKDSIQMKFKESGAITFWEFYEGHVDTRNGHGAII
GGKRWGAMVVLKSLESASTAIVAALKDSAQFNSSEGNMMHIALLSAENESNISGISDD
QAQHKMEKLSKILKDTSVASDLQAAGLKVISCIVQRDEARMPMRHTFLWLDDKSCYEE
EQILRHVEPPLSTLLELDKLKVKGYNEMKYTPSRDRQWHIYTLRNTENPKMLHRVFFR
TIVRQPNAGNKFTSAQISDAEVGCPEESLSFTSNSILRSLMTAIEELELHAIRTGHSH
MYLCILKEQKLLDLIPFSGSTIVDVGQDEATACSLLKSMALKIHELVGARMHHLSVCQ
WEVKLKLDCDGPASGTWRVVTTNVTGHTCTIDIYREVEEIESQKLVYHSATSSAGPLH
GVALNNPYQPLSVIDLKRCSARNNRTTYCYDFPLAFETALQKSWQTNGSTVSEGNENS
KSYVKATELVFAEKHGSWGTPIIPMERPAGLNDIGMVAWIMEMSTPEFPNGRQIIVVA
NDITFRAGSFGPREDAFFETVTNLACERKLPLIYLAANSGARIGIADEVKSCFRVGWS
DEGSPERGFQYIYLTEEDYARISSSVIAHKLELDSGEIRWIIDSVVGKEDGLGVENIH
GSAAIASAYSRAYEETFTLTFVTGRTVGIGAYLARLGIRCIQRLDQPIILTGFSALNK
LLGREVYSSHMQLGGPKIMATNGVVHLTVPDDLEGVSNILRWLSYVPANIGGPLPITK
PLDPPDRPVAYIPENTCDPRAAICGVDDSQGKWLGGMFDKDSFVETFEGWAKTVVTGR
AKLGGIPVGVIAVETQTMMQIIPADPGQLDSHERSVPRAGQVWFPDSATKTAQALLDF
NREGLPLFILANWRGFSGGQRDLFEGILQAGSTIVENLRTYNQPAFVYIPMAGELRGG
AWVVVDSKINPDRIECYAERTAKGNVLEPQGLIEIKFRSEELQDCMGRLDPELINLKA
KLQDVNHGNGSLPDIEGIRKSIEARTKQLLPLYTQIAIRFAELHDTSLRMAAKGVIKK
VVDWEESRSFFYKRLRRRIAEDVLAKEIRQIVGDKFTHQLAMELIKEWYLASQATTGS
TGWDDDDAFVAWKDSPENYKGHIQKLRAQKVSHSLSDLADSSSDLQAFSQGLSTLLDK
MDPSQRAKFVQEVKKVLD

FIGURE 11A

>AF029895_Triticum aestivum
ATGGGATCCACACATTTGCCCATTGTCGGCCTTAATGCCTCGACAACACCATCGCTATCCACTATTCGCC
CGGTAAATTCAGCCGGTGCTGCATTCCAACCATCTGCCCCTTCTAGAACCTCCAAGAAGAAAAGTCGTCG
TGTTCAGTCATTAAGGGATGGAGGCGATGGAGGCGTGTCAGACCCTAACCAGTCTATTCGCCAAGGTCTT
GCCGGCATCATTGACCTCCCAAAGGAGGGCACATCAGCTCCGGAAGTGGATATTTCACATGGGTCCGAAG
AACCCAGGGGCTCCTACCAAATGAATGGGATACTGAATGAAGCACATAATGGGAGGCATGCTTCGCTGTC
TAAGGTTGTCGAATTTTGTATGGCATTGGGCGGCAAAACACCAATTCACAGTGTATTAGTTGCGAACAAT
GGAATGGCAGCAGCTAAGTTCATGCGGAGTGTCCGAACATGGGCTAATGAAACATTTGGGTCAGAGAAGG
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TCAATTTGTTGAAGTACCCGGTGGAACAAACAATAACAACTATGCAAATGTCCAACTCATAGTGGAGATA
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GCTAAGGCTGTGGGTTATGTTGGTGCTGCTACTGTTGAATATCTCTACAGCATGGAGACTGGTGAATACT
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GGAATGGACAATGGAGGAGGCTATGACATTTGGAGGAAAACAGCAGCTCTTGCTACTCCATTTAACTTCG
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TTCTCTGTTAAGTCCGGTGGAGGCATTCATGAATTTGCTGATTCTCAGTTTGGACATGTTTTTGCATATG
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TGTCATTAATGTTTTGTTGTCTGAGGGCCAGCCTATGCAGGCTGGTGATCTTATAGCAAGACTTGATCTT
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CTTTGTTTGATTGTAGTGATCAAACTCTTCAGCAGAGGGTGATCGAGACGTACATATCTCGATTATACCA

GCCTCATCTTGTCAAGGATAGTATCCAGCTGAAATATCAGGAATCTGGTGTTATTGCTTTATGGGAATTC
GCTGAAGCGCATTCAGAGAAGAGATTGGGTGCTATGGTTATTGTGAAGTCGTTAGAATCTGTATCAGCAG
CAATTGGAGCTGCACTAAAGGGTACATCACGCTATGCAAGCTCTGAGGGTAACATAATGCATATTGCTTT
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GGATATCTACCGTGAGGTCGAAGATACAGAATCACAGAAACTAGTGTACCACTCTGCTCCATCGTCATCT
GGTCCTTTGCATGGCGTTGCACTGAATACTCCATATCAGCCTTTGAGTGTTATTGATCTGAAACGTTGCT
CCGCTAGAAATAACAGAACTACATACTGCTATGATTTTCCGTTGGCATTTGAAACTGCAGTGCAGAAGTC
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CTTGGATCTTGGACATGTCCACTCCTGAATATCCCAATGGCAGGCAGATTGTTGTCATCGCAAATGATAT
TACTTTTAGAGCTGGATCGTTTGGTCCAAGGGAAGATGCATTTTTTGAAACTGTTACCAACCTAGCTTGT
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TGAAGAAGACCATGCTCGTATTAGCGCTTCTGTTATAGCGCACAAGATGCAGCTTGATAATGGTGAAATT
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CTATTGCCAGTGCCTATTCTAGGGCCTATGAGGAGACATTTACGCTTACATTTGTGACTGGAAGGACTGT
TGGAATAGGAGCATATCTTGCTCGACTTGGCATACGGTGCATACAGCGTACTGACCAGCCCATTATCCTA
ACTGGGTTCTCTGCCTTGAACAAGCTTCTTGGCCGGGAAGTTTACAGCTCCCACATGCAGTTGGGTGGCC
CCAAAATTATGGCGACAAACGGTGTTGTCCATCTGACAGTTTCAGATGACCTTGAAGGTGTATCTAATAT
ATTGAGGTGGCTCAGCTATGTTCCTGCCAACATTGGTGGACCTCTTCCTATTACAAAATCTTTGGACCCA
CCTGACAGACCCGTTGCTTACATCCCTGAGAATACATGCGATCCTCGTGCTGCCATCAGTGGCATTGATG
ATAGCCAAGGGAAATGGTTGGGGGGCATGTTCGACAAAGACAGTTTTGTGGAGACATTTGAAGGATGGGC
GAAGTCAGTTGTTACTGGCAGAGCGAAACTCGGAGGGATTCCGGTGGGTGTTATAGCTGTGGAGACACAG
ACTATGATGCAGCTCATCCCTGCTGATCCAGGCCAGCTTGATTCCCATGAGCGATCTGTTCCTCGTGCTG
GGCAAGTCTGGTTTCCAGATTCAGCTACTAAGACAGCGCAGGCAATGCTGGACTTCAACCGTGAAGGATT
ACCTCTGTTCATCCTTGCTAACTGGAGAGGCTTCTCTGGTGGACAAAGAGATCTTTTTGAAGGAATCCTT
CAGGCTGGGTCAACAATTGTTGAGAACCTTAGGACATACAATCAGCCTGCCTTTGTATATATCCCCAAGG
CTGCAGAGCTACGTGGAGGGGCTTGGGTCGTGATTGATAGCAAGATAAATCCAGATCGCATTGAGTTCTA
TGCTGAGAGGACTGCAAAGGGCAATGTTCTCGAACCTCAAGGGTTGATCGAGATCAAGTTCAGGTCAGAG
GAACTCCAAGAGTGCATGGGTAGGCTTGATCCAGAATTGATAAATCTGAAGGCAAAGCTCCAGGGAGTAA
AGCATGAAAATGGAAGTCTACCTGAGTCAGAATCCCTTCAGAAGAGCATAGAAGCCCGGAAGAAACAGTT
GTTGCCTTTGTATACTCAAATTGCGGTACGGTTCGCTGAATTGCATGACACTTCCCTTAGAATGGCTGCT
AAGGGTGTGATTAAGAAGGTTGTAGACTGGGAAGATTCTAGGTCGTTCTTCTACAAGAGATTACGGAGGA
GGATATCCGAGGATGTTCTTGCGAAGGAAATTAGAGGTGTAAGTGGCAAGCAGTTTTCTCACCAATCGGC
AATCGAGCTGATCCAGAAATGGTACTTGGCCTCTAAGGGAGCTGAAACAGGAAGCACTGAATGGGATGAT
GACGATGCTTTTGTTGCCTGGAGGGAAAACCCTGAAAACTACCAGGAGTATATCAAAGAACTCAGGGCTC
AAAGGGTATCTCAGTTGCTCTCAGATGTTGCAGACTCCAGTCCAGATCTAGAAGCCTTGCCACAGGGTCT
TTCTATGCTATTAGAGAAGATGGATCCCTCAAGGAGAGCACAGTTTGTTGAGGAAGTCAAGAAAGTCCTT
AAATGA

FIGURE 11B

>AAC39330_Triticum aestivum
MGSTHLPIVGLNASTTPSLSTIRPVNSAGAAFQPSAPSRTSKKK
SRRVQSLRDGGDGGVSDPNQSIRQGLAGIIDLPKEGTSAPEVDISHGSEEPRGSYQMN
GILNEAHNGRHASLSKVVEFCMALGGKTPIHSVLVANNGMAAAKFMRSVRTWANETFG
SEKAIQLIAMATPEDMRINAEHIRIADQFVEVPGGTNNNNYANVQLIVEIAVRTGVSA
VWPGWGHASENPELPDALNANGIVFLGPPSSSMNALGDKVGSALIAQAAGVPTLPWSG
SQVEIPLEVCLDSIPAEMYRKACVSTTEEALASCQMIGYPAMIKASWGGGGKGIRKVN
NDDDVRALFKQVQGEVPGSPIFIMRLASQSRHLEVQLLCDQYGNVAALHSRDCSVQRR
HQKIIEEGPVTVAPRETVKELEQAARRLAKAVGYVGAATVEYLYSMETGEYYFLELNP
RLQVEHPVTEWIAEVNLPAAQVAVGMGIPLWQVPEIRRFYGMDNGGGYDIWRKTAALA
TPFNFDEVDSQWPKGHCVAVRITSEDPDDGFKPTGGKVKEISFKSKPNVWAYFSVKSG
GGIHEFADSQFGHVFAYGVSRAAAITNMSLALKEIQIRGEIHSNVDYTVDLLNASDFK
ENRIHTGWLDNRIAMRVQAERPPWYISVVGGALYKTITSNTDTVSEYVSYLVKGQIPP
KHISLVHSTVSLNIEESKYTIETIRSGQGSYRLRMNGSVIEANVQTLCDGGLLMQLDG
NSHVIYAEEEAGGTRLLIDGKTCLLQNDHDPSRLLAETPCKLLRFLVADGAHVEADVP
YAEVEVMKMCMPLLSPAAGVINVLLSEGQPMQAGDLIARLDLDDPSAVKRAEPFNGSF
PEMSLPIAASGQVHKRCATSLNAARMVLAGYDHPINKVVQDLVSCLDAPELPFLQWEE
LMSVLATRLPRLLKSELEGKYSEYKLNVGHGKSKDFPSKMLREIIEENLAHGSEKEIA
TNERLVEPLMSLLKSYEGGRESHAHFIVKSLFEDYLSVEELFSDGIQSDVIERLRQQH
SKDLQKVVDIVLSHQGVRNKTKLILTLMEKLVYPNPAVYKDQLTRFSSLNHKRYYKLA
LKASELLEQTKLSELRTSIARSLSELEMFTEERTAISEIMGDLVTAPLPVEDALVSLF
DCSDQTLQQRVIETYISRLYQPHLVKDSIQLKYQESGVIALWEFAEAHSEKRLGAMVI
VKSLESVSAAIGAALKGTSRYASSEGNIMHIALLGADNQMHGTEDSGDNDQAQVRIDK
LSATLEQNTVTADLRAAGVKVISCIVQRDGALMPMRHTFLLSDEKLCYEEEPVLRHVE
PPLSALLELGKLKVKGYNEVKYTPSRDRQWNIYTLRNTENPKMLHRVFFRTLVRQPGA
SNKFTSGNISDVEVGGAEESLSFTSSSILRSLMTAIEELELHAIRTGHSHMFLCILKE
QKLLDLVPVSGNKVVDIGQDEATACLLLKEMALQIHELVGARMHHLSVCQWEVKLKLD
SDGPASGTWRVVTTNVTSHTCTVDIYREVEDTESQKLVYHSAPSSSGPLHGVALNTPY
QPLSVIDLKRCSARNNRTTYCYDFPLAFETAVQKSWSNISSDTNRCYVKATELVFAHK
NGSWGTPVIPMERPAGLNDIGMVAWILDMSTPEYPNGRQIVVIANDITFRAGSFGPRE
DAFFETVTNLACERKLPLIYLAANSGARIGIADEVKSCFRVGWSDDGSPERGFQYIYL
TEEDHARISASVIAHKMQLDNGEIRWVIDSVVGKEDGLGVENIHGSAAIASAYSRAYE
ETFTLTFVTGRTVGIGAYLARLGIRCIQRTDQPIILTGFSALNKLLGREVYSSHMQLG
GPKIMATNGVVHLTVSDDLEGVSNILRWLSYVPANIGGPLPITKSLDPPDRPVAYIPE
NTCDPRAAISGIDDSQGKWLGGMFDKDSFVETFEGWAKSVVTGRAKLGGIPVGVIAVE
TQTMMQLIPADPGQLDSHERSVPRAGQVWFPDSATKTAQAMLDFNREGLPLFILANWR
GFSGGQRDLFEGILQAGSTIVENLRTYNQPAFVYIPKAAELRGGAWVVIDSKINPDRI
EFYAERTAKGNVLEPQGLIEIKFRSEELQECMGRLDPELINLKAKLQGVKHENGSLPE
SESLQKSIEARKKQLLPLYTQIAVRFAELHDTSLRMAAKGVIKKVVDWEDSRSFFYKR
LRRRISEDVLAKEIRGVSGKQFSHQSAIELIQKWYLASKGAETGSTEWDDDDAFVAWR
ENPENYQEYIKELRAQRVSQLLSDVADSSPDLEALPQGLSMLLEKMDPSRRAQFVEEV
KKVLK

FIGURE 12A

>AY219174_Setaria italica (foxtail millet)
ATGTCGCAACTTGGATTAGCTGCAGCTGCCTCAAAGGCGCTGCCACTACTTCCTAATCGCCATAGAACTT
CAGCTGGAACTACATTCCCATCACCTGTATCATCGCGGCCCTCAAACCGAAGGAAAAGCCGCACTCGTTC
ACTTCGTGATGGAGGAGATGGGGTATCAGATGCCAAAAAGCACAACCAGTCTGTCCGTCAAGGTCTTGCT
GGCATCATCGACCTCCCAAATGAGGCAACATCGGAAGTGGATATTTCTCATGGATCCGAGGATCCCAGGG
GGCCAACCGATTCATATCAAATGAATGGGATTGTAAGTGAAGCACATAATGGCAGACATGCCTCAGTGTC
CAAGGTTGTTGAATTTTGTGCGGCGCTAGGTGGCAAAACACCAATTCACAGTATACTAGTGGCCAACAAT
GGAATGGCAGCAGCAAAGTTCATGAGGAGTGTCCGGACATGGGCTAATGATACTTTTGGATCGGAGAAGG
CGATTCAGCTCATAGCTATGGCAACTCCAGAAGACATGAGGATAAATGCAGAACACATTAGAATTGCTGA
TCAATTTGTGGAGGTGCCTGGTGGAACAAACAATAACAACTATGCAAATGTTCAACTCATAGTGGAGGTA
GCAGAAAGAATAGGTGTTTCTGCTGTTTGGCCTGGTTGGGGTCATGCTTCTGAGAATCCTGAACTTCCAG
ATGCATTGACCGCAAAAGGAGTTGTTTTCCTTGGGCCACCTGCGGCATCAATGAATGCATTGGGAGATAA
GGTCGGTTCAGCTCTCATTGCTCAAGCAGCTGGGGTCCCGACCCTTTCGTGGAGTGGATCACATGTTGAA
GTTCCATTAGAGTGCTGCTTAGATGCGATACCTGAGGAAATGTATAGAAAAGCTTGTGTTACTACCACAG
AAGAAGCTGTTGCGAGTTGTCAGGTGGTTGGTTATCCTGCCATGATTAAGGCATCCTGGGGAGGTGGTGG
TAAAGGAATAAGAAAGGTTCATAATGACGATGAGGTTAGAGCACTGTTTAAGCAAGTACAAGGTGAAGTC
CCTGGCTCCCCAATATTTATCATGAGGCTTGCATCCCAGAGTCGTCATCTTGAAGTTCAGTTGCTTTGTG
ATCAATATGGCAATGTGGCAGCACTTCACAGTCGTGATTGCAGTGTGCAACGGCGACACCAAAAGATTAT
TGAGGAAGGCCCAGTTACTGTTGCTCCTCGTGAGACAGTTAAAGCGCTTGAGCAGGCAGCAAGGAGGCTT
GCTAAGGCTGTGGGTTATGTTGGTGCTGCTACTGTTGAATACCTTTACAGCATGGAGACTGGGGAATACT
ATTTTCTGGAGCTTAATCCCAGATTACAGGTCGAGCATCCAGTCACTGAGTGGATTGCTGAAGTAAATCT
TCCTGCAGCTCAAGTTGCAGTTGGAATGGGCATACCTCTTTGGCAGATTCCAGAAATCAGACGTTTCGAT
GGAATGGACTATGGAGGAGGATATGACATTTGGAGGAAAACAGCAGCTCTTGCCACACCATTTAATTTTG
ATGAAGTAGATTCTCAATGGCCAAAGGGCCATTGTGTAGCAGTTAGAATTACTAGCGAGGATCCAGATGA
TGGTTTCAAACCTACTGGTGGGAAAGTGAAGGAGATAAGTTTTAAAAGCAAGCCTAATGTTTGGGCCTAC
TTCTCAGTAAAGTCTGGTGGAGGCATTCATGAATTTGTTGATTCTCAGTTTGGGCATGTTTTTGCATATG
GGCTCTCTAGATCAGCAGCAATAACGAACATGGCTCTTGCATTAAAAGAGATTCAAATTCGTGGAGAAAT
TCATTCAAATGTTGATTACACAGTTGATCTCTTAAATGCTTCAGACTTCAGAGAAAATAAGATTCATACT
GGCTGGCTTGATACCAGAATAGCTATGCGTGTTCAAGCTGAGAGGCCCCCATGGTATATTTCAGTGGTTG
GAGGAGCTCTATATAAAACAGTAACTGCCAATGCAGCCACTGTTTCTGATTATGTCAGTTATCTCACCAA
GGGCCAGATTCCACCAAAGCATATATCCCTTGTCAGTTCAACAGTTAATCTGAATATCGAAGGGAGCAAA
TACACAGTTGAAACTGTAAGGACTGGACATGGTAGCTACAGATTACGAATGAATGATTCAGCAATTGAAG
CGAATGTACAATCCTTATGTGATGGAGGCCTCTTAATGCAGTTGGATGGAAATAGCCATGTAATTTACGC
GGAAGAAGAAGCTGGTGGTACACGACTTCTGATTGATGGAAAGACATGCTTGTTACAGAATGATCATGAT
CCATCAAAGTTATTAGCTGAGACACCCTGCAAACTTCTTCGGTTCTTGGTTGCTGATGGTGCCCATGTTG
ATGCTGATGTACCATATGCGGAAGTTGAGGTTATGAAAATGTGCATGCCTCTCTTGTCGCCTGCTTCTGG
TGTCATTCATGTTATGATGTCTGAGGGCCAGGCATTGCAGGCTGGTGATCTTATAGCAAGGCTGGATCTT
GATGACCCTTCTGCTGTGAAAAGAGCTGAACCATTTCATGGAATATTTCCACAAATGGACCTTCCTGTTG
CTGCCTCTAGCCAAGTACACAAAAGATATGCTGCAAGTTGGAATGCTGCTCGAATGGTCCTTGCAGGATA
CGAGCATAATATCAATGAAGTTGTACAAGATTTGGTATGCTGCCTGGATGATCCCGAGCTTCCCTTCCTA
CAGTGGGATGAACTTATGTCAGTTCTAGCAACTAGGCTTCCAAGAAATCTTAAGAGTGAGTTAGAGGATA
AATACATGGAATACAAGTTGAACTTTTACCATGGGAAAAACAAGGACTTCCCGTCCAAGCTGCTGAGAGA
CATCATTGAGGCAAATCTTGCATATGGTTCAGAGAAGGAAAAAGCTACGAATGAGAGGCTTATTGAGCCT
CTTATGAGCCTACTTAAGTCATATGAGGGTGGGAGAGAAAGCCATGCTCATTTTGTTGTCAAGTCCCTTT
TCAAGGAGTACCTTGCTGTGGAAGAACTTTTCAGTGATGGGATTCAGTCTGATGTGATTGAAACCCTGCG
TCATCAGCACAGTAAAGACTTGCAGAAGGTTGTAGACATTGTGTTGTCTCACCAGGGTGTGAGGAACAAA
GCTAAGCTTGTAACAGCACTTATGGAAAAGCTGGTTTATCCAAATCCTGCTGCTTACAGGGATCTGTTGG
TTCGCTTTTCTTCACTCAATCATAAAAGATATTATAAGTTGGCCCTTAAAGCAAGCGAACTTCTTGAACA
AACTAAACTAAGTGAACTCCGTGCAAGCATCGCAAGAAGCCTTTCTGATCTGGGGATGCATAAGGGAGAA
ATGACTATTGAAGATAGCATGGAAGATTTAGTCTCTGCCCCATTACCTGTCGAAGATGCACTTATTTCTT
TGTTTGATTACAGTGATCCAACTGTTCAGCAGAAAGTGATCGAGACATACATATCTCGATTGTATCAGCC
TCTTCTTGTGAAAGATAGCATCCAAGTGAAATTTAAGGAATCTGGTGCCTTTGCTTTATGGGAATTTTCT
GAAGGGCATGTTGATACTAAAAATGGACAAGGGACCGTTCTTGGTCGAACAAGATGGGGTGCCATGGTAG
CTGTCAAATCAGTTGAATCTGCACGAACAGCCATTGTAGCTGCATTAAAGGATTCGGCACAGCATGCCAG

CTCTGAGGGCAACATGATGCACATTGCCTTATTGAGTGCTGAAAATGAAAATAATATCAGTGATGATCAA
GCTCAACATAGGATGGAAAAACTTAACAAGATACTCAAGGATACTAGTGTCGCAAATGATCTTCGAGCTG
CTGGTTTGAAGGTTATAAGTTGCATTGTTCAAAGAGATGAAGCACGCATGCCAATGCGCCACACATTACT
CTGGTCAGATGAAAAGAGTTGTTATGAGGAAGAGCAGATTCTTCGGCATGTGGAGCCTCCCCTCTCCATG
CTTCTTGAAATGGATAAGTTGAAAGTGAAAGGATACAATGAAATGAAGTATACTCCATCACGTGATCGTC
AATGGCATATCTACACACTAAGAAATACTGAAAACCCCAAAATGTTGCATAGGGTATTTTTCCGAACTAT
TGTCAGGCAACCCAATGCAGGCAACAAGTTTATATCAGCCCAAATTGGCGACACTGAAGTAGGAGGTCCT
GAGGAATCTTTGTCATTTACATCTAATAGCATTTTAAGAGCCTTGATGACTGCTATTGAAGAATTAGAGC
TTCATGCAATTAGGACTGATCATTCTCACATGTATTTGTGCATATTGAAAGAACAAAAGCTTCTTGATCT
CATTCCGTTTTCAGGGAGCACAATCGTCGATGTTGTCCAAGACGAAGCTACTGCTTGTTCACTTTTAAAA
TCAATGGCTTTGAAGATACACGAACTTGTTGGTGCACAGATGCATCATCTTTCTGTATGCCAGTGGGAGG
TGAAACTCAAGTTGTACTGCGATGGGCCTGCCAGTGGCACCTGGAGAGTTGTAACTACAAATGTTACTAG
TCACACTTGCACCGTTGATATCTACCGGGAAGTGGAAGATACTGAATCGCAGAAGTTAGTATACCATTCA
GCTTCTCCGTCAGCTAGTCCTTTGCATGGTGTGGCCCTGGATAATCCGTATCAACCTTTGAGTGTCATTG
ATCTAAAACACTGCTCTGCTAGGAACAACAGAACTACATATTGCTATGATTTTCCACTGGCATTTGAAAC
TGCCCTGCAGAAGTCATGGCAGTCCAATGGCTCCAGTGTTTCTGAAGGCAGTGAAAATAGTAGGTCTTAT
GTGAAAGCAACAGAGCTGGTGTTTGCTGAAAAACATGGGTCCTGGGGCACTCCTATAATTTCCATGGAGC
GTCCCGCTGGGCTCAATGACATTGGCATGGTAGCTTGGATCTTAGAGATGTCCACTCCTGAATTTCCCAA
TGGCAGGCAGATTATTGTCATAGCAAATGATATTACTTTCAGAGCTGGATCATTTGGCCCAAGGGAAGAT
GCGTTTTTTGAAGCTGTCACGAACCTGGCCTGCGAGAGGAAGCTTCCTCTTATATACTTGGCAGCAAACT
CCGGTGCTAGGATTGGCATAGCCGATGAAGTGAAATCTTGCTTCCGTGTTGGGTGGTCCGATGAAGGCAG
CCCTGAACGGGGTTTTCAGTACATTTATCTGACTGACGAAGACTATGCCCGTATTAGCTTGTCTGTTATA
GCACACAAGCTGCAGCTGGATAATGGTGAAATTAGGTGGATTATTGACTCTGTTGTGGGCAAGGAGGATG
GGCTTGGTGTTGAGAATATACATGGAAGTGCTGCTATTGCCAGTGCTTATTCTAGGGCATATGAGGAGAC
ATTTACACTTACATTTGTGACTGGGCGGACTGTTGGAATAGGAGCATATCTTGCTCGGCTCGGTATACGG
TGCATACAGCGTCTTGACCAGCCTATTATTTTAACTGGGTTTTCTGCCCTGAACAAGCTTCTTGGGCGGG
AAGTGTACAGCTCCCACATGCAGTTGGGTGGTCCTAAGATCATGGCGACCAATGGTGTTGTCCACTTGAC
TGTTTCAGATGACCTTGAAGGTGTTTCCAATATATTGAGGTGGCTCAGCTATGTTCCTGCCAACATTGGT
GGACCTCTTCCTATTACAAAACCTTTGGACCCACCAGACAGACCTGTTGCATACATCCCTGAGAACACAT
GTGATCCGCGCGCAGCCATTCGTGGTGTAGATGACAGCCAAGGGAAATGGTTGGGTGGTATGTTTGACAA
AGACAGCTTTGTCGAGACATTTGAAGGATGGGCGAAAACAGTGGTTACGGGCAGAGCAAAGCTTGGAGGA
ATTCCTGTTGGCGTCATAGCTGTGGAGACACAAACCATGATGCAGCTTATCCCTGCTGATCCAGGCCAGC
TTGATTCCCATGAGCGATCTGTTCCTCGGGCTGGACAAGTGTGGTTCCCAGATTCTGCAACCAAGACAGC
TCAGGCATTGTTGGACTTCAACCGTGAAGGATTGCCGCTGTTCATCCTTGCTAACTGGAGAGGATTCTCT
GGTGGACAAAGAGATCTGTTTGAAGGAATTCTTCAGGCTGGGTCAACAATTGTTGAGAACCTTAGGACAT
ACAATCAGCCTGCTTTTGTCTACATTCCTATGGCTGGAGAGCTGCGTGGAGGAGCTTGGGTTGTGGTTGA
TAGCAAAATAAATCCAGACCGAATTGAGTGTTATGCTGAGAGGACTGCTAAAGGCAATGTTCTGGAACCT
CAAGGGTTAATTGAAATCAAATTCAGATCAGAGGAGCTCCAAGACTGTATGGGTAGGCTTGACCCAGGGT
TGATAAATCTGAAAGCAAAACTCCAAGGTGCAAAGCTTGGAAATGGAAGCCTAACAGATGTAGAATCCCT
TCAGAAGAGTATAGATGCTCGTACGAAACAGTTGTTGCCTTTATACACCCAGATTGCAATACGGTTTGCT
GAATTGCATGATACTTCCCTCAGAATGGCAGCTAAAGGTGTGATTAAGAAAGTTGTAGATTGGGAAGAAT
CACGTTCTTTCTTCTACAGAAGGCTACGGAGGAGGATCTCTGAAGATGTTCTTGCAAAAGAAATAAGAGG
AATAGCTGGTGACCACTTCACTCACCAATCAGCAGTTGAGCTGATCAAGGAATGGTACTTGGCTTCTCAA
GCCACAACAGGAAGCACTGAATGGGATGATGATGATGCTTTTGTTGCCTGGAAGGAGAATCCTGAAAACT
ATAAGGGATATATCCAAGAGTTAAGGGCTCAAAAGGTGTCTCAGTCGCTCTCCGATCTTGCAGACTCCAG
TTCAGATCTAGAAGCATTCTCACAGGGTCTTTCCACATTATTAGATAAGATGGATCCCTCTCAGAGAGCC
AAGTTCATTCAGGAAGTCAAGAAGGTCCTGGGTTGA

FIGURE 12B

>AAO62902_Setaria italica (foxtail millet)
MSQLGLAAAASKALPLLPNRHRTSAGTTFPSPVSSRPSNRRKSR
TRSLRDGGDGVSDAKKHNQSVRQGLAGIIDLPNEATSEVDISHGSEDPRGPTDSYQMN
GIVSEAHNGRHASVSKVVEFCAALGGKTPIHSILVANNGMAAAKFMRSVRTWANDTFG
SEKAIQLIAMATPEDMRINAEHIRIADQFVEVPGGTNNNNYANVQLIVEVAERIGVSA
VWPGWGHASENPELPDALTAKGVVFLGPPAASMNALGDKVGSALIAQAAGVPTLSWSG
SHVEVPLECCLDAIPEEMYRKACVTTTEEAVASCQVVGYPAMIKASWGGGGKGIRKVH
NDDEVRALFKQVQGEVPGSPIFIMRLASQSRHLEVQLLCDQYGNVAALHSRDCSVQRR
HQKIIEEGPVTVAPRETVKALEQAARRLAKAVGYVGAATVEYLYSMETGEYYFLELNP
RLQVEHPVTEWIAEVNLPAAQVAVGMGIPLWQIPEIRRFDGMDYGGGYDIWRKTAALA
TPFNFDEVDSQWPKGHCVAVRITSEDPDDGFKPTGGKVKEISFKSKPNVWAYFSVKSG
GGIHEFVDSQFGHVFAYGLSRSAAITNMALALKEIQIRGEIHSNVDYTVDLLNASDFR
ENKIHTGWLDTRIAMRVQAERPPWYISVVGGALYKTVTANAATVSDYVSYLTKGQIPP
KHISLVSSTVNLNIEGSKYTVETVRTGHGSYRLRMNDSAIEANVQSLCDGGLLMQLDG
NSHVIYAEEEAGGTRLLIDGKTCLLQNDHDPSKLLAETPCKLLRFLVADGAHVDADVP
YAEVEVMKMCMPLLSPASGVIHVMMSEGQALQAGDLIARLDLDDPSAVKRAEPFHGIF
PQMDLPVAASSQVHKRYAASWNAARMVLAGYEHNINEVVQDLVCCLDDPELPFLQWDE
LMSVLATRLPRNLKSELEDKYMEYKLNFYHGKNKDFPSKLLRDIIEANLAYGSEKEKA
TNERLIEPLMSLLKSYEGGRESHAHFVVKSLFKEYLAVEELFSDGIQSDVIETLRHQH
SKDLQKVVDIVLSHQGVRNKAKLVTALMEKLVYPNPAAYRDLLVRFSSLNHKRYYKLA
LKASELLEQTKLSELRASIARSLSDLGMHKGEMTIEDSMEDLVSAPLPVEDALISLFD
YSDPTVQQKVIETYISRLYQPLLVKDSIQVKFKESGAFALWEFSEGHVDTKNGQGTVL
GRTRWGAMVAVKSVESARTAIVAALKDSAQHASSEGNMMHIALLSAENENNISDDQAQ
HRMEKLNKILKDTSVANDLRAAGLKVISCIVQRDEARMPMRHTLLWSDEKSCYEEEQI
LRHVEPPLSMLLEMDKLKVKGYNEMKYTPSRDRQWHIYTLRNTENPKMLHRVFFRTIV
RQPNAGNKFISAQIGDTEVGGPEESLSFTSNSILRALMTAIEELELHAIRTDHSHMYL
CILKEQKLLDLIPFSGSTIVDVVQDEATACSLLKSMALKIHELVGAQMHHLSVCQWEV
KLKLYCDGPASGTWRVVTTNVTSHTCTVDIYREVEDTESQKLVYHSASPSASPLHGVA
LDNPYQPLSVIDLKHCSARNNRTTYCYDFPLAFETALQKSWQSNGSSVSEGSENSRSY
VKATELVFAEKHGSWGTPIISMERPAGLNDIGMVAWILEMSTPEFPNGRQIIVIANDI
TFRAGSFGPREDAFFEAVTNLACERKLPLIYLAANSGARIGIADEVKSCFRVGWSDEG
SPERGFQYIYLTDEDYARISLSVIAHKLQLDNGEIRWIIDSVVGKEDGLGVENIHGSA
AIASAYSRAYEETFTLTFVTGRTVGIGAYLARLGIRCIQRLDQPIILTGFSALNKLLG
REVYSSHMQLGGPKIMATNGVVHLTVSDDLEGVSNILRWLSYVPANIGGPLPITKPLD
PPDRPVAYIPENTCDPRAAIRGVDDSQGKWLGGMFDKDSFVETFEGWAKTVVTGRAKL
GGIPVGVIAVETQTMMQLIPADPGQLDSHERSVPRAGQVWFPDSATKTAQALLDFNRE
GLPLFILANWRGFSGGQRDLFEGILQAGSTIVENLRTYNQPAFVYIPMAGELRGGAWV
VVDSKINPDRIECYAERTAKGNVLEPQGLIEIKFRSEELQDCMGRLDPGLINLKAKLQ
GAKLGNGSLTDVESLQKSIDARTKQLLPLYTQIAIRFAELHDTSLRMAAKGVIKKVVD
WEESRSFFYRRLRRRISEDVLAKEIRGIAGDHFTHQSAVELIKEWYLASQATTGSTEW
DDDDAFVAWKENPENYKGYIQELRAQKVSQSLSDLADSSSDLEAFSQGLSTLLDKMDP
SQRAKFIQEVKKVLG

FIGURE 13A

>AY219175 _Setaria italica (foxtail millet)
ATGTCGCAACTTGGATTAGCTGCAGCTGCCTCAAAGGCGCTGCCACTACTTCCTAATCGCCATAGAACTT
CAGCTGGAACTACATTCCCATCACCTGTATCATCGCGGCCCTCAAACCGAAGGAAAAGCCGCACTCGTTC
ACTTCGTGATGGAGGAGATGGGGTATCAGATGCCAAAAAGCACAACCAGTCTGTCCGTCAAGGTCTTGCT
GGCATCATCGACCTCCCAAATGAGGCAACATCGGAAGTGGATATTTCTCATGGATCCGAGGATCCCAGGG
GGCCAACCGATTCATATCAAATGAATGGGATTGTAAATGAAGCACATAATGGCAGACATGCCTCAGTGTC
CAAGGTTGTTGAATTTTGTGCGGCGCTAGGTGGCAAAACACCAATTCACAGTATACTAGTGGCCAACAAT
GGAATGGCAGCAGCAAAGTTCATGAGGAGTGTCCGGACATGGGCTAATGATACTTTTGGATCGGAGAAGG
CGATTCAGCTCATAGCTATGGCAACTCCAGAAGACATGAGGATAAATGCAGAACACATTAGAATTGCTGA
TCAATTTGTAGAGGTGCCTGGTGGAACAAACAATAACAACTATGCAAATGTTCAACTCATAGTGGAGGTA
GCAGAAAGAATAGGTGTTTCTGCTGTTTGGCCTGGTTGGGGTCATGCTTCTGAGAATCCTGAACTTCCAG
ATGCATTGACCGCAAAAGGAATTGTTTTCCTTGGGCCACCTGCGGCATCAATGAATGCATTGGGAGATAA
GGTCGGTTCAGCTCTCATTGCTCAAGCAGCTGGGGTCCCGACCCTTTCGTGGAGTGGATCACATGTTGAA
GTTCCATTAGAGTGCTGCTTAGATGCGATACCTGAGGAAATGTATAGAAAAGCTTGTGTTACTACCACAG
AAGAAGCTGTTGCGAGTTGTCAGGTGGTTGGTTATCCTGCCATGATTAAGGCATCCTGGGGAGGTGGTGG
TAAAGGAATAAGAAAGGTTCATAATGACGATGAGGTTAGAGCACTGTTTAAGCAAGTACAAGGTGAAGTC
CCTGGCTCCCCAATATTTATCATGAGGCTTGCATCCCAGAGTCGTCATCTTGAAGTTCAGTTGCTTTGTG
ATCAATATGGCAATGTGGCAGCACTTCACAGTCGTGATTGCAGTGTGCAACGGCGACACCAAAAGATTAT
TGAGGAAGGCCCAGTTACTGTTGCTCCTCGTGAGACAGTTAAAGCGCTTGAGCAGGCAGCAAGGAGGCTT
GCTAAGGCTGTGGGTTATGTTGGTGCTGCTACTGTTGAATACCTTTACAGCATGGAGACTGGGGAATACT
ATTTTCTGGAGCTTAATCCCAGATTACAGGTCGAGCATCCAGTCACTGAGTGGATTGCTGAAGTAAATCT
TCCTGCAGCTCAAGTTGCAGTTGGAATGGGCATACCTCTTTGGCAGATTCCAGAAATCAGACGTTTCTAT
GGAATGGACTATGGAGGAGGATATGACATTTGGAGGAAAACAGCAGCTCTTGCCACACCATTTAATTTTG
ATGAAGTAGATTCTCAATGGCCAAAGGGCCATTGTGTAGCAGTTAGAATTACTAGCGAGGATCCAGATGA
TGGTTTCAAACCTACTGGTGGGAAAGTGAAGGAGATAAGTTTTAAAAGCAAGCCTAATGTTTGGGCCTAC
TTCTCAGTAAAGTCTGGTGGAGGCATTCATGAATTTGCTGATTCTCAGTTTGGGCATGTTTTTGCATATG
GGCTCTCTAGATCAGCAGCAATAACGAACATGGCTCTTGCATTAAAAGAGATTCAAATTCGTGGAGAAAT
TCATTCAAATGTTGATTACACAGTTGATCTCTTAAATGCTTCAGACTTCAGAGAAAATAAGATTCATACT
GGCTGGCTTGATACCAGAATAGCTATGCGTGTTCAAGCTGAGAGGCCCCCATGGTATATTTCAGTGGTTG
GAGGAGCTCTATATAAAACAGTAACTGCCAATGCAGCCACTGTTTCTGATTATGTCAGTTATCTCACCAA
GGGCCAGATTCCACCAAAGCATATATCCCTTGTCAGTTCAACAGTTAATCTGAATATCGAAGGGAGCAAA
TACACAGTTGAAACTGTAAGGACTGGACATGGTAGCTACAGATTACGAATGAATGATTCAGCAATTGAAG
CGAATGTACAATCTTTATGTGATGGAGGCCTCTTAATGCAGTTGGATGGAAATAGCCATGTAATTTACGC
GGAAGAAGAAGCTGGTGGTACACGACTTCTGATTGATGGAAAGACATGCTTGTTACAGAATGATCATGAT
CCATCAAAGTTATTAGCTGAGACACCCTGCAAACTTCTTCGGTTCTTGGTTGCTGATGGTGCTCATGTTG
ATGCTGATGTACCATATGCGGAAGTTGAGGTTATGAAAATGTGCATGCCTCTCTTGTCGCCTGCTTCTGG
TGTCATTCATGTTATGATGTCTGAGGGCCAGGCATTGCAGGCTGGTGATCTTATAGCAAGGCTGGATCTT
GATGACCCTTCTGCTGTGAAAAGAGCTGAACCATTTCATGGAATATTTCCACAAATGGACCTTCCTGTTG
CTGCCTCTAGCCAAGTACACAAAAGATATGCTGCAAGTTTGAATGCTGCTCGAATGGTCCTTGCAGGATA
CGAGCATAATATCAATGAAGTTGTACAAGATTTGGTATGCTGCCTGGATGATCCCGAGCTTCCCTTCCTA
CAGTGGGATGAACTTATGTCAGTTCTAGCAACTAGGCTTCCAAGAAATCTTAAGAGTGAGTTAGAGGATA
AATACATGGAATACAAGTTGAACTTTTACCATGGGAAAAACAAGGACTTCCCGTCCAAGCTGCTGAGAGA
CATCATTGAGGCAAATCTTGCATATGGTTCAGAGAAGGAAAAAGCTACGAATGAGAGGCTTATTGAGCCT
CTTATGAGCCTACTTAAGTCATATGAGGGTGGGAGAGAAAGCCATGCTCATTTTGTTGTCAAGTCCCTTT
TCAAGGAGTACCTTGCTGTGGAAGAACTTTTCAGTGATGGGATTCAGTCTGATGTGATTGAAACCCTGCG
TCATCAGCACAGTAAAGACTTGCAGAAGGTTGTAGACATTGTGTTGTCTCACCAGGGTGTGAGGAACAAA
GCTAAGCTTGTAACAGCACTTATGGAAAAGCTGGTTTATCCAAATCCTGCTGCTTACAGGGATCTGTTGG
TTCGCTTTTCTTCACTCAATCATAAAAGATATTATAAGTTGGCCCTTAAAGCAAGCGAACTTCTTGAACA
AACTAAACTAAGTGAACTCCGTGCAAGCATCGCAAGAAGCCTTTCTGATCTGGGGATGCATAAGGGAGAA
ATGACTATTGAAGATAGCATGGAAGATTTAGTCTCTGCCCCATTACCTGTCGAAGATGCACTTATTTCTT
TGTTTGATTACAGTGATCCAACTGTTCAGCAGAAAGTGATCGAGACATACATATCTCGATTGTATCAGCC
TCTTCTTGTGAAAGATAGCATCCAAGTGAAATTTAAGGAATCTGGTGCCTTTGCTTTATGGGAATTTTCT
GAAGGGCATGTTGATACTAAAAATGGACAAGGGACCGTTCTTGGTCGAACAAGATGGGGTGCCATGGTAG
CTGTCAAATCAGTTGAATCTGCACGAACAGCCATTGTAGCTGCATTAAAGGATTCGGCACAGCATGCCAG

CTCTGAGGGCAACATGATGCACATTGCCTTATTGAGTGCTGAAAATGAAAATAATATCAGTGATGATCAA
GCTCAACATAGGATGGAAAAACTTAACAAGATACTCAAGGATACTAGTGTCGCAAATGATCTTCGAGCTG
CTGGTTTGAAGGTTATAAGTTGCATTGTTCAAAGAGATGAAGCACGCATGCCAATGCGCCACACATTACT
CTGGTCAGATGAAAAGAGTTGTTATGAGGAAGAGCAGATTCTTCGGCATGTGGAGCCTCCCCTCTCCATG
CTTCTTGAAATGGATAAGTTGAAAGTGAAAGGATACAATGAAATGAAGTATACTCCATCACGTGATCGTC
AATGGCATATCTACACACTAAGAAATACTGAAAACCCCAAAATGTTGCATAGGGTATTTTTCCGAACTAT
TGTCAGGCAACCCAATGCAGGCAACAAGTTTATATCAGCCCAAATTGGCGACACTGAAGTAGGAGGTCCT
GAGGAATCTTTGTCATTTACATCTAATAGCATTTTAAGAGCCTTGATGACTGCTATTGAAGAATTAGAGC
TTCATGCAATTAGGACTGGTCATTCTCACATGTATTTGTGCATATTGAAAGAACAAAAGCTTCTTGATCT
CATTCCGTTTTCAGGGAGCACAATCGTCGATGTTGGCCAAGACGAAGCTACTGCTTGTTCACTTTTAAAA
TCAATGGCTTTGAAGATACACGAACTTGTTGGTGCACAGATGCATCATCTTTCTGTATGCCAGTGGGAGG
TGAAACTCAAGTTGTACTGCGATGGGCCTGCCAGTGGCACCTGGAGAGTTGTAACTACAAATGTTACTAG
TCACACTTGCACCATTGATATCTACCGGGAAGTGGAAGATACTGAATCGCAGAAGTTAGTATACCATTCA
GCTTCTCCGTCAGCTAGTCCTTTGCATGGTGTGGCCCTGGATAATCCGTATCAACCTTTGAGTGTCATTG
ATCTAAAACGCTGCTCTGCTAGGAACAACAGAACTACATATTGCTATGATTTTCCACTGGCATTTGAAAC
TGCCCTGCAGAAGTCATGGCAGTCCAATGGCTCCAGTGTTTCTGAAGGCAGTGAAAATAGTAGGTCTTAT
GTGAAAGCAACAGAGCTGGTGTTTGCTGAAAAACATGGGTCCTGGGGCACTCCTATAATTTCCATGGAGC
GTCCCGCTGGGCTCAATGACATTGGCATGGTAGCTTGGATCTTAGAGATGTCCACTCCTGAATTTCCCAA
TGGCAGGCAGATTATTGTCATAGCAAATGATATTACTTTCAGAGCTGGATCATTTGGCCCAAGGGAAGAT
GCGTTTTTTGAAGCTGTCACGAACCTGGCCTGCGAGAGGAAGCTTCCTCTTATATACTTGGCAGCAAACT
CCGGTGCTAGGATTGGCATAGCCGATGAAGTGAAATCTTGCTTCCGTGTTGGGTGGTCCGATGAAGGCAG
CCCTGAACGGGGTTTTCAGTACATTTATCTGACTGACGAAGACTATGCCCGTATTAGCTTGTCTGTTATA
GCACACAAGCTGCAGCTGGATAATGGTGAAATTAGGTGGATTATTGACTCTGTTGTGGGCAAGGAGGATG
GGCTTGGTGTTGAGAATCTACATGGAAGTGCTGCTATTGCCAGTGCTTATTCTAGGGCATATGAGGAGAC
ATTTACACTTACATTTGTGACTGGGCGGACTGTTGGAATAGGAGCATATCTCGCTCGGCTCGGTATACGG
TGCATACAGCGTCTTGACCAGCCTATTATTTTAACTGGGTTTTCTGCCCTGAACAAGCTTCTTGGGCGGG
AAGTGTACAGCTCCCACATGCAGTTGGGTGGTCCTAAGATCATGGCGACCAATGGTGTTGTCCACTTGAC
TGTTTCAGATGACCTTGAAGGTGTTTCCAATATATTGAGGTGGCTCAGCTATGTTCCTGCCAACATTGGT
GGACCTCTTCCTATTACAAAACCTTTGGACCCACCAGACAGACCTGTTGCATACATCCCTGAGAACACAT
GTGATCCGCGCGCAGCCATTCGTGGTGTAGATGACAGCCAAGGGAAATGGTTGGGTGGTATGTTTGACAA
AGACAGCTTTGTCGAGACATTTGAAGGATGGGCGAAAACAGTGGTTACGGGCAGAGCAAAGCTTGGAGGA
ATTCCTGTTGGTGTCATAGCTGTGGAGACACAAACCATGATGCAGCTTATCCCTGCTGATCCAGGCCAGC
TTGATTCCCATGAGCGATCTGTTCCTCGGGCTGGACAAGTGTGGTTCCCAGATTCTGCAACCAAGACAGC
TCAGGCATTGTTGGACTTCAACCGTGAAGGATTGCCGCTGTTCATCCTTGCTAACTGGAGAGGATTCTCT
GGTGGACAAAGAGATCTGTTTGAAGGAATTCTTCAGGCTGGGTCAACAATTGTTGAGAACCTTAGGACAT
ACAATCAGCCTGCTTTTGTCTACATTCCTATGGCTGGAGAGCTGCGTGGAGGAGCTTGGGTTGTGGTTGA
TAGCAAAATAAATCCAGACCGAATTGAGTGTTATGCTGAGAGGACTGCTAAAGGCAATGTTCTTGAACCT
CAAGGGTTAATTGAAATCAAATTCAGATCAGAGGAGCTCCAAGACTGTATGGGTAGGCTTGACCCAGAGT
TGATAAATCTGAAAGCAAAACTCCAAGGTGCAAAGCTTGGAAATGGAAGCCTAACAGATGTAGAATCCCT
TCAGAAGAGTATAGATGCTCGTACGAAACAGTTGTTGCCTTTATACACCCAGATTGCAATACGGTTTGCT
GAATTGCATGATACTTCCCTCAGAATGGCAGCTAAAGGTGTGATTAAGAAAGTTGTAGATTGGGAAGAAT
CACGTTCTTTCTTCTACAGAAGGCTACGGAGGAGGATCTCTGAAGATGTTCTTGCAAAAGAAATAAGAGG
AATAGCTGGTGACCACTTCACTCACCAATCAGCAGTTGAGCTGATCAAGGAATGGTACTTGGCTTCTCAA
GCCACAACAGGAAGCACTGAATGGGATGATGATGATGCTTTTGTTGCCTGGAAGGAGAATCCTGAAAACT
ATAAGGGATATATCCAAGAGTTAAGGGCTCAAAAGGTGTCTCAGTCGCTCTCCGATCTTGCAGACTCCAG
TTCAGATCTAGAAGCATTCTCACAGGGTCTTTCCACATTATTAGATAAGATGGATCCCTCTCAGAGAGCC
AAGTTCATTCAGGAAGTCAAGAAGGTCCTGGGTTGA

FIGURE 13B

>AAO62903_Setaria italica (foxtail millet)
MSQLGLAAAASKALPLLPNRHRTSAGTTFPSPVSSRPSNRRKSR
TRSLRDGGDGVSDAKKHNQSVRQGLAGIIDLPNEATSEVDISHGSEDPRGPTDSYQMN
GIVNEAHNGRHASVSKVVEFCAALGGKTPIHSILVANNGMAAAKFMRSVRTWANDTFG
SEKAIQLIAMATPEDMRINAEHIRIADQFVEVPGGTNNNNYANVQLIVEVAERIGVSA
VWPGWGHASENPELPDALTAKGIVFLGPPAASMNALGDKVGSALIAQAAGVPTLSWSG
SHVEVPLECCLDAIPEEMYRKACVTTTEEAVASCQVVGYPAMIKASWGGGGKGIRKVH
NDDEVRALFKQVQGEVPGSPIFIMRLASQSRHLEVQLLCDQYGNVAALHSRDCSVQRR
HQKIIEEGPVTVAPRETVKALEQAARRLAKAVGYVGAATVEYLYSMETGEYYFLELNP
RLQVEHPVTEWIAEVNLPAAQVAVGMGIPLWQIPEIRRFYGMDYGGGYDIWRKTAALA
TPFNFDEVDSQWPKGHCVAVRITSEDPDDGFKPTGGKVKEISFKSKPNVWAYFSVKSG
GGIHEFADSQFGHVFAYGLSRSAAITNMALALKEIQIRGEIHSNVDYTVDLLNASDFR
ENKIHTGWLDTRIAMRVQAERPPWYISVVGGALYKTVTANAATVSDYVSYLTKGQIPP
KHISLVSSTVNLNIEGSKYTVETVRTGHGSYRLRMNDSAIEANVQSLCDGGLLMQLDG
NSHVIYAEEEAGGTRLLIDGKTCLLQNDHDPSKLLAETPCKLLRFLVADGAHVDADVP
YAEVEVMKMCMPLLSPASGVIHVMMSEGQALQAGDLIARLDLDDPSAVKRAEPFHGIF
PQMDLPVAASSQVHKRYAASLNAARMVLAGYEHNINEVVQDLVCCLDDPELPFLQWDE
LMSVLATRLPRNLKSELEDKYMEYKLNFYHGKNKDFPSKLLRDIIEANLAYGSEKEKA
TNERLIEPLMSLLKSYEGGRESHAHFVVKSLFKEYLAVEELFSDGIQSDVIETLRHQH
SKDLQKVVDIVLSHQGVRNKAKLVTALMEKLVYPNPAAYRDLLVRFSSLNHKRYYKLA
LKASELLEQTKLSELRASIARSLSDLGMHKGEMTIEDSMEDLVSAPLPVEDALISLFD
YSDPTVQQKVIETYISRLYQPLLVKDSIQVKFKESGAFALWEFSEGHVDTKNGQGTVL
GRTRWGAMVAVKSVESARTAIVAALKDSAQHASSEGNMMHIALLSAENENNISDDQAQ
HRMEKLNKILKDTSVANDLRAAGLKVISCIVQRDEARMPMRHTLLWSDEKSCYEEEQI
LRHVEPPLSMLLEMDKLKVKGYNEMKYTPSRDRQWHIYTLRNTENPKMLHRVFFRTIV
RQPNAGNKFISAQIGDTEVGGPEESLSFTSNSILRALMTAIEELELHAIRTGHSHMYL
CILKEQKLLDLIPFSGSTIVDVGQDEATACSLLKSMALKIHELVGAQMHHLSVCQWEV
KLKLYCDGPASGTWRVVTTNVTSHTCTIDIYREVEDTESQKLVYHSASPSASPLHGVA
LDNPYQPLSVIDLKRCSARNNRTTYCYDFPLAFETALQKSWQSNGSSVSEGSENSRSY
VKATELVFAEKHGSWGTPIISMERPAGLNDIGMVAWILEMSTPEFPNGRQIIVIANDI
TFRAGSFGPREDAFFEAVTNLACERKLPLIYLAANSGARIGIADEVKSCFRVGWSDEG
SPERGFQYIYLTDEDYARISLSVIAHKLQLDNGEIRWIIDSVVGKEDGLGVENLHGSA
AIASAYSRAYEETFTLTFVTGRTVGIGAYLARLGIRCIQRLDQPIILTGFSALNKLLG
REVYSSHMQLGGPKIMATNGVVHLTVSDDLEGVSNILRWLSYVPANIGGPLPITKPLD
PPDRPVAYIPENTCDPRAAIRGVDDSQGKWLGGMFDKDSFVETFEGWAKTVVTGRAKL
GGIPVGVIAVETQTMMQLIPADPGQLDSHERSVPRAGQVWFPDSATKTAQALLDFNRE
GLPLFILANWRGFSGGQRDLFEGILQAGSTIVENLRTYNQPAFVYIPMAGELRGGAWV
VVDSKINPDRIECYAERTAKGNVLEPQGLIEIKFRSEELQDCMGRLDPELINLKAKLQ
GAKLGNGSLTDVESLQKSIDARTKQLLPLYTQIAIRFAELHDTSLRMAAKGVIKKVVD
WEESRSFFYRRLRRRISEDVLAKEIRGIAGDHFTHQSAVELIKEWYLASQATTGSTEW
DDDDAFVAWKENPENYKGYIQELRAQKVSQSLSDLADSSSDLEAFSQGLSTLLDKMDP
SQRAKFIQEVKKVLG

FIGURE 14A

>AF294805_Setaria italica (foxtail millet)
ATGTCGCAACTTGGATTAGCTGCAGCTGCCTCAAAGGCGCTGCCACTACTTCCTAATCGCCATAGAACTT
CAGCTGGAACTACATTCCCATCACCTGTATCATCGCGGCCCTCAAACCGAAGGAAAAGCCGCACTCGTTC
ACTTCGTGATGGAGGAGATGGGGTATCAGATGCCAAAAAGCACAACCAGTCTGTCCGTCAAGGTCTTGCT
GGCATCATCGACCTCCCAAATGAGGCAACATCGGAAGTGGATATTTCTCATGGATCCGAGGATCCCAGGG
GGCCAACCGATTCATATCAAATGAATGGGATTGTAAATGAAGCACATAATGGCAGACATGCCTCAGTGTC
CAAGGTTGTTGAATTTTGTGCGGCGCTAGGTGGCAAAACACCAATTCACAGTATACTAGTGGCCAACAAT
GGAATGGCAGCAGCAAAGTTCATGAGGAGTGTCCGGACATGGGCTAATGATACTTTTGGATCGGAGAAGG
CGATTCAGCTCATAGCTATGGCAACTCCAGAAGACATGAGGATAAATGCAGAACACATTAGAATTGCTGA
TCAATTTGTAGAGGTGCCTGGTGGAACAAACAATAACAACTATGCAAATGTTCAACTCATAGTGGAGGTA
GCAGAAAGAATAGGTGTTTCTGCTGTTTGGCCTGGTTGGGGTCATGCTTCTGAGAATCCTGAACTTCCAG
ATGCATTGACCGCAAAAGGAATTGTTTTCCTTGGGCCACCTGCGGCATCAATGAATGCATTGGGAGATAA
GGTCGGTTCAGCTCTCATTGCTCAAGCAGCTGGGGTCCCGACCCTTTCGTGGAGTGGATCACATGTTGAA
GTTCCATTAGAGTGCTGCTTAGATGCGATACCTGAGGAAATGTATAGAAAAGCTTGTGTTACTACCACAG
AAGAAGCTGTTGCGAGTTGTCAGGTGGTTGGTTATCCTGCCATGATTAAGGCATCCTGGGGAGGTGGTGG
TAAAGGAATAAGAAAGGTTCATAATGACGATGAGGTTAGAGCACTGTTTAAGCAAGTACAAGGTGAAGTC
CCTGGCTCCCCAATATTTATCATGAGGCTTGCATCCCAGAGTCGTCATCTTGAAGTTCAGTTGCTTTGTG
ATCAATATGGCAATGTGGCAGCACTTCACAGTCGTGATTGCAGTGTGCAACGGCGACACCAAAAGATTAT
TGAGGAAGGCCCAGTTACTGTTGCTCCTCGTGAGACAGTTAAAGCGCTTGAGCAGGCAGCAAGGAGGCTT
GCTAAGGCTGTGGGTTATGTTGGTGCTGCTACTGTTGAATACCTTTACAGCATGGAGACTGGGGAATACT
ATTTTCTGGAGCTTAATCCCAGATTACAGGTCGAGCATCCAGTCACTGAGTGGATTGCTGAAGTAAATCT
TCCTGCAGCTCAAGTTGCAGTTGGAATGGGCATACCTCTTTGGCAGATTCCAGAAATCAGACGTTTCTAT
GGAATGGACTATGGAGGAGGATATGACATTTGGAGGAAAACAGCAGCTCTTGCCACACCATTTAATTTTG
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TGGTTTCAAACCTACTGGTGGGAAAGTGAAGGAGATAAGTTTTAAAAGCAAGCCTAATGTTTGGGCCTAC
TTCTCAGTAAAGTCTGGTGGAGGCATTCATGAATTTGCTGATTCTCAGTTTGGGCATGTTTTTGCATATG
GGCTCTCTAGATCAGCAGCAATAACGAACATGGCTCTTGCATTAAAAGAGATTCAAATTCGTGGAGAAAT
TCATTCAAATGTTGATTACACAGTTGATCTCTTAAATGCTTCAGACTTCAGAGAAAATAAGATTCATACT
GGCTGGCTTGATACCAGAATAGCTATGCGTGTTCAAGCTGAGAGGCCCCCATGGTATATTTCAGTGGTTG
GAGGAGCTCTATATAAAACAGTAACTGCCAATGCAGCCACTGTTTCTGATTATGTCAGTTATCTCACCAA
GGGCCAGATTCCACCAAAGCATATATCCCTTGTCAGTTCAACAGTTAATCTGAATATCGAAGGGAGCAAA
TACACAGTTGAAACTGTAAGGACTGGACATGGTAGCTACAGATTACGAATGAATGATTCAGCAATTGAAG
CGAATGTACAATCTTTATGTGATGGAGGCCTCTTAATGCAGTTGGATGGAAATAGCCATGTAATTTACGC
GGAAGAAGAAGCTGGTGGTACACGACTTCTGATTGATGGAAAGACATGCTTGTTACAGAATGATCATGAT
CCATCAAAGTTATTAGCTGAGACACCCTGCAAACTTCTTCGGTTCTTGGTTGCTGATGGTGCTCATGTTG
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GATGACCCTTCTGCTGTGAAAAGAGCTGAACCATTTCATGGAATATTTCCACAAATGGACCTTCCTGTTG
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AATACATGGAATACAAGTTGAACTTTTACCATGGGAAAAACAAGGACTTCCCGTCCAAGCTGCTGAGAGA
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TCATCAGCACAGTAAAGACTTGCAGAAGGTTGTAGACATTGTGTTGTCTCACCAGGGTGTGAGGAACAAA
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AACTAAACTAAGTGAACTCCGTGCAAGCATCGCAAGAAGCCTTTCTGATCTGGGGATGCATAAGGGAGAA
ATGACTATTGAAGATAGCATGGAAGATTTAGTCTCTGCCCCATTACCTGTCGAAGATGCACTTATTTCTT
TGTTTGATTACAGTGATCCAACTGTTCAGCAGAAAGTGATCGAGACATACATATCTCGATTGTATCAGCC
TCTTCTTGTGAAAGATAGCATCCAAGTGAAATTTAAGGAATCTGGTGCCTTTGCTTTATGGGAATTTTCT

GAAGGGCATGTTGATACTAAAAATGGACAAGGGACCGTTCTTGGTCGAACAAGATGGGGTGCCATGGTAG
CTGTCAAATCAGTTGAATCTGCACGAACAGCCATTGTAGCTGCATTAAAGGATTCGGCACAGCATGCCAG
CTCTGAGGGCAACATGATGCACATTGCCTTATTGAGTGCTGAAAATGAAAATAATATCAGTGATGATCAA
GCTCAACATAGGATGGAAAAACTTAACAAGATACTCAAGGATACTAGTGTCGCAAATGATCTTCGAGCTG
CTGGTTTGAAGGTTATAAGTTGCATTGTTCAAAGAGATGAAGCACGCATGCCAATGCGCCACACATTACT
CTGGTCAGATGAAAAGAGTTGTTATGAGGAAGAGCAGATTCTTCGGCATGTGGAGCCTCCCCTCTCCATG
CTTCTTGAAATGGATAAGTTGAAAGTGAAAGGATACAATGAAATGAAGTATACTCCATCACGTGATCGTC
AATGGCATATCTACACACTAAGAAATACTGAAAACCCCAAAATGTTGCATAGGGTATTTTTCCGAACTAT
TGTCAGGCAACCCAATGCAGGCAACAAGTTTATATCAGCCCAAATTGGCGACACTGAAGTAGGAGGTCCT
GAGGAATCTTTGTCATTTACATCTAATAGCATTTTAAGAGCCTTGATGACTGCTATTGAAGAATTAGAGC
TTCATGCAATTAGGACTGGTCATTCTCACATGTATTTGTGCATATTGAAAGAACAAAAGCTTCTTGATCT
CATTCCGTTTTCAGGGAGCACAATCGTCGATGTTGGCCAAGACGAAGCTACTGCTTGTTCACTTTTAAAA
TCAATGGCTTTGAAGATACACGAACTTGTTGGTGCACAGATGCATCATCTTTCTGTATGCCAGTGGGAGG
TGAAACTCAAGTTGTACTGCGATGGGCCTGCCAGTGGCACCTGGAGAGTTGTAACTACAAATGTTACTAG
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GCTTCTCCGTCAGCTAGTCCTTTGCATGGTGTGGCCCTGGATAATCCGTATCAACCTTTGAGTGTCATTG
ATCTAAAACGCTGCTCTGCTAGGAACAACAGAACTACATATTGCTATGATTTTCCACTGGCATTTGAAAC
TGCCCTGCAGAAGTCATGGCAGTCCAATGGCTCCAGTGTTTCTGAAGGCAGTGAAAATAGTAGGTCTTAT
GTGAAAGCAACAGAGCTGGTGTTTGCTGAAAAACATGGGTCCTGGGGCACTCCTATAATTTCCATGGAGC
GTCCCGCTGGGCTCAATGACATTGGCATGGTAGCTTGGATCTTAGAGATGTCCACTCCTGAATTTCCCAA
TGGCAGGCAGATTATTGTCATAGCAAATGATATTACTTTCAGAGCTGGATCATTTGGCCCAAGGGAAGAT
GCGTTTTTTGAAGCTGTCACGAACCTGGCCTGCGAGAGGAAGCTTCCTCTTATATACTTGGCAGCAAACT
CCGGTGCTAGGATTGGCATAGCCGATGAAGTGAAATCTTGCTTCCGTGTTGGGTGGTCCGATGAAGGCAG
CCCTGAACGGGGTTTTCAGTACATTTATCTGACTGACGAAGACTATGCCCGTATTAGCTTGTCTGTTATA
GCACACAAGCTGCAGCTGGATAATGGTGAAATTAGGTGGATTATTGACTCTGTTGTGGGCAAGGAGGATG
GGCTTGGTGTTGAGAATATACATGGAAGTGCTGCTATTGCCAGTGCTTATTCTAGGGCATATGAGGAGAC
ATTTACACTTACATTTGTGACTGGGCGGACTGTTGGAATAGGAGCATATCTTGCTCGGCTCGGTATACGG
TGCATACAGCGTCTTGACCAGCCTATTATTTTAACTGGGTTTTCTGCCCTGAACAAGCTTCTTGGGCGGG
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TGTTTCAGATGACCTTGAAGGTGTTTCCAATATATTGAGGTGGCTCAGCTATGTTCCTGCCAACATTGGT
GGACCTCTTCCTATTACAAAACCTTTGGACCCACCAGACAGACCTGTTGCATACATCCCTGAGAACACAT
GTGATCCGCGCGCAGCCATTCGTGGTGTAGATGACAGCCAAGGGAAATGGTTGGGTGGTATGTTTGACAA
AGACAGCTTTGTCGAGACATTTGAAGGATGGGCGAAAACAGTGGTTACGGGCAGAGCAAAGCTTGGAGGA
ATTCCTGTTGGTGTCATAGCTGTGGAGACACAAACCATGATGCAGCTTATCCCTGCTGATCCAGGCCAGC
TTGATTCCCATGAGCGATCTGTTCCTCGGGCTGGACAAGTGTGGTTCCCAGATTCTGCAACCAAGACAGC
TCAGGCATTGTTGGACTTCAACCGTGAAGGATTGCCGCTGTTCATCCTTGCTAACTGGAGAGGATTCTCT
GGTGGACAAAGAGATCTGTTTGAAGGAATTCTTCAGGCTGGGTCAACAATTGTTGAGAACCTTAGGACAT
ACAATCAGCCTGCTTTTGTCTACATTCCTATGGCTGGAGAGCTGCGTGGAGGAGCTTGGGTTGTGGTTGA
TAGCAAAATAAATCCAGACCGAATTGAGTGTTATGCTGAGAGGACTGCTAAAGGCAATGTTCTGGAACCT
CAAGGGTTAATTGAAATCAAATTCAGATCAGAGGAGCTCCAAGACTGTATGGGTAGGCTTGACCCAGAGT
TGATAAATCTGAAAGCAAAACTCCAAGGTGCAAAGCTTGGAAATGGAAGCCTAACAGATGTAGAATCCCT
TCAGAAGAGTATAGATGCTCGTACGAAACAGTTGTTGCCTTTATACACCCAGATTGCAATACGGTTTGCT
GAATTGCATGATACTTCCCTCAGAATGGCAGCTAAAGGTGTGATTAAGAAAGTTGTAGATTGGGAAGAAT
TACGTTCTTTCTTCTACAGAAGGCTACGGAGGAGGATCTCTGAAGATGTTCTTGCAAAAGAAATAAGAGG
AATAGCTGGTGACCACTTCACTCACCAATCAGCAGTTGAGCTGATCAAGGAATGGTACTTGGCTTCTCAA
GCCACAACAGGAAGCACTGAATGGGATGATGATGATGCTTTTGTTGCCTGGAAGGAGAATCCTGAAAACT
ATAAGGGATATATCCAAGAGTTAAGGGCTCAAAAGGTGTCTCAGTCGCTCTCCGATCTTGCAGACTCCAG
TTCAGATCTAGAAGCATTCTCACAGGGTCTTTCCACATTATTAGATAAGATGGATCCCTCTCAGAGAGCC
AAGTTCATTCAGGAAGTCAAGAAGGTCCTGGGTTGA

FIGURE 14B

>AAL02056_Setaria italica (foxtail millet)
MSQLGLAAAASKALPLLPNRHRTSAGTTFPSPVSSRPSNRRKSR
TRSLRDGGDGVSDAKKHNQSVRQGLAGIIDLPNEATSEVDISHGSEDPRGPTDSYQMN
GIVNEAHNGRHASVSKVVEFCAALGGKTPIHSILVANNGMAAAKFMRSVRTWANDTFG
SEKAIQLIAMATPEDMRINAEHIRIADQFVEVPGGTNNNNYANVQLIVEVAERIGVSA
VWPGWGHASENPELPDALTAKGIVFLGPPAASMNALGDKVGSALIAQAAGVPTLSWSG
SHVEVPLECCLDAIPEEMYRKACVTTTEEAVASCQVVGYPAMIKASWGGGGKGIRKVH
NDDEVRALFKQVQGEVPGSPIFIMRLASQSRHLEVQLLCDQYGNVAALHSRDCSVQRR
HQKIIEEGPVTVAPRETVKALEQAARRLAKAVGYVGAATVEYLYSMETGEYYFLELNP
RLQVEHPVTEWIAEVNLPAAQVAVGMGIPLWQIPEIRRFYGMDYGGGYDIWRKTAALA
TPFNFDEVDSQWPKGHCVAVRITSEDPDDGFKPTGGKVKEISFKSKPNVWAYFSVKSG
GGIHEFADSQFGHVFAYGLSRSAAITNMALALKEIQIRGEIHSNVDYTVDLLNASDFR
ENKIHTGWLDTRIAMRVQAERPPWYISVVGGALYKTVTANAATVSDYVSYLTKGQIPP
KHISLVSSTVNLNIEGSKYTVETVRTGHGSYRLRMNDSAIEANVQSLCDGGLLMQLDG
NSHVIYAEEEAGGTRLLIDGKTCLLQNDHDPSKLLAETPCKLLRFLVADGAHVDADVP
YAEVEVMKMCMPLLSPASGVIHVMMSEGQALQAGDLIARLDLDDPSAVKRAEPFHGIF
PQMDLPVAASSQVHKRYAASLNAARMVLAGYEHNINEVVQDLVCCLDDPELPFLQWDE
LMSVLATRLPRNLKSELEDKYMEYKLNFYHGKNKDFPSKLLRDIIEANLAYGSEKEKA
TNERLIEPLMSLLKSYEGGRESHAHFVVKSLFKEYLAVEELFSDGIQSDVIETLRHQH
SKDLQKVVDIVLSHQGVRNKAKLVTALMEKLVYPNPAAYRDLLVRFSSLNHKRYYKLA
LKASELLEQTKLSELRASIARSLSDLGMHKGEMTIEDSMEDLVSAPLPVEDALISLFD
YSDPTVQQKVIETYISRLYQPLLVKDSIQVKFKESGAFALWEFSEGHVDTKNGQGTVL
GRTRWGAMVAVKSVESARTAIVAALKDSAQHASSEGNMMHIALLSAENENNISDDQAQ
HRMEKLNKILKDTSVANDLRAAGLKVISCIVQRDEARMPMRHTLLWSDEKSCYEEEQI
LRHVEPPLSMLLEMDKLKVKGYNEMKYTPSRDRQWHIYTLRNTENPKMLHRVFFRTIV
RQPNAGNKFISAQIGDTEVGGPEESLSFTSNSILRALMTAIEELELHAIRTGHSHMYL
CILKEQKLLDLIPFSGSTIVDVGQDEATACSLLKSMALKIHELVGAQMHHLSVCQWEV
KLKLYCDGPASGTWRVVTTNVTSHTCTVDIYREVEDTESQKLVYHSASPSASPLHGVA
LDNPYQPLSVIDLKRCSARNNRTTYCYDFPLAFETALQKSWQSNGSSVSEGSENSRSY
VKATELVFAEKHGSWGTPIISMERPAGLNDIGMVAWILEMSTPEFPNGRQIIVIANDI
TFRAGSFGPREDAFFEAVTNLACERKLPLIYLAANSGARIGIADEVKSCFRVGWSDEG
SPERGFQYIYLTDEDYARISLSVIAHKLQLDNGEIRWIIDSVVGKEDGLGVENIHGSA
AIASAYSRAYEETFTLTFVTGRTVGIGAYLARLGIRCIQRLDQPIILTGFSALNKLLG
REVYSSHMQLGGPKIMATNGVVHLTVSDDLEGVSNILRWLSYVPANIGGPLPITKPLD
PPDRPVAYIPENTCDPRAAIRGVDDSQGKWLGGMFDKDSFVETFEGWAKTVVTGRAKL
GGIPVGVIAVETQTMMQLIPADPGQLDSHERSVPRAGQVWFPDSATKTAQALLDFNRE
GLPLFILANWRGFSGGQRDLFEGILQAGSTIVENLRTYNQPAFVYIPMAGELRGGAWV
VVDSKINPDRIECYAERTAKGNVLEPQGLIEIKFRSEELQDCMGRLDPELINLKAKLQ
GAKLGNGSLTDVESLQKSIDARTKQLLPLYTQIAIRFAELHDTSLRMAAKGVIKKVVD
WEELRSFFYRRLRRRISEDVLAKEIRGIAGDHFTHQSAVELIKEWYLASQATTGSTEW
DDDDAFVAWKENPENYKGYIQELRAQKVSQSLSDLADSSSDLEAFSQGLSTLLDKMDP
SQRAKFIQEVKKVLG

FIGURE 15A

>AJ310767_Alopecurus myosuroides (black-grass)
ATGGGATCCACACATCTGCCCATTGTCGGGTTTAATGCATCCACAACACCATCGCTATCCACTCTTCGCC
AGATAAACTCAGCTGCTGCTGCATTCCAATCTTCGTCCCCTTCAAGGTCATCCAAGAAGAAAAGCCGACG
TGTTAAGTCAATAAGGGATGATGGCGATGGAAGCGTGCCAGACCCTGCAGGCCATGGCCAGTCTATTCGC
CAAGGTCTCGCTGGCATCATCGACCTCCCAAAGGAGGGCGCATCAGCTCCAGATGTGGACATTTCACATG
GGTCTGAAGACCACAAGGCCTCCTACCAAATGAATGGGATACTGAATGAATCACATAACGGGAGGCACGC
CTCTCTGTCTAAAGTTTATGAATTTTGCACGGAATTGGGTGGAAAAACACCAATTCACAGTGTATTAGTC
GCCAACAATGGAATGGCAGCAGCTAAGTTCATGCGGAGTGTCCGGACATGGGCTAATGATACATTTGGGT
CAGAGAAGGCGATTCAGTTGATAGCTATGGCAACTCCGGAAGACATGAGAATAAATGCAGAGCACATTAG
AATTGCTGATCAGTTTGTTGAAGTACCTGGTGGAACAAACAATAACAACTATGCAAATGTCCAACTCATA
GTGGAGATAGCAGAGAGAACTGGTGTCTCCGCCGTTTGGCCTGGTTGGGGCCATGCATCTGAGAATCCTG
AACTTCCAGATGCACTAACTGCAAAAGGAATTGTTTTTCTTGGGCCACCAGCATCATCAATGAACGCACT
AGGCGACAAGGTTGGTTCAGCTCTCATTGCTCAAGCAGCAGGGGTTCCCACTCTTGCTTGGAGTGGATCA
CATGTGGAAATTCCATTAGAACTTTGTTTGGACTCGATACCTGAGGAGATGTATAGGAAAGCCTGTGTTA
CAACCGCTGATGAAGCAGTTGCAAGTTGTCAGATGATTGGTTACCCTGCCATGATCAAGGCATCCTGGGG
TGGTGGTGGTAAAGGGATTAGAAAGGTTAATAATGATGACGAGGTGAAAGCACTGTTTAAGCAAGTACAG
GGTGAAGTTCCTGGCTCCCCGATATTTATCATGAGACTTGCATCTCAGAGTCGTCATCTTGAAGTCCAGC
TGCTTTGTGATGAATATGGCAATGTAGCAGCACTTCACAGTCGTGATTGCAGTGTGCAACGACGACACCA
AAAGATTATCGAGGAAGGACCAGTTACTGTTGCTCCTCGTGAAACAGTGAAAGAGCTAGAGCAAGCAGCA
AGGAGGCTTGCTAAGGCCGTGGGTTACGTCGGTGCTGCTACTGTTGAATATCTCTACAGCATGGAGACTG
GTGAATACTATTTTCTGGAGCTTAATCCACGGTTGCAGGTTGAGCACCCAGTCACCGAGTCGATAGCTGA
AGTAAATTTGCCTGCAGCCCAAGTTGCAGTTGGGATGGGTATACCCCTTTGGCAGATTCCAGAGATCAGA
CGTTTCTACGGAATGGACAATGGAGGAGGCTATGATATTTGGAGGAAAACAGCAGCTCTCGCTACTCCAT
TCAACTTTGATGAAGTAGATTCTCAATGGCCGAAGGGTCATTGTGTGGCAGTTAGGATAACCAGTGAGAA
TCCAGATGATGGATTCAAGCCTACTGGTGGAAAAGTAAAGGAGATAAGTTTTAAAAGTAAGCCAAATGTC
TGGGGATATTTCTCAGTTAAGTCTGGTGGAGGCATTCATGAATTTGCGGATTCTCAGTTTGGACACGTTT
TTGCCTATGGAGAGACTAGATCAGCAGCAATAACCAGCATGTCTCTTGCACTAAAAGAGATTCAAATTCG
TGGAGAAATTCATACAAACGTTGATTACACGGTTGATCTCTTGAATGCCCCAGACTTCAGAGAAAACACG
ATCCATACCGGTTGGCTGGATACCAGAATAGCTATGCGTGTTCAAGCTGAGAGGCCTCCCTGGTATATTT
CAGTGGTTGGAGGAGCTCTATATAAAACAATAACCACCAATGCGGAGACCGTTTCTGAATATGTTAGCTA
TCTCATCAAGGGTCAGATTCCACCAAAGCACATATCCCTTGTCCATTCAACTATTTCTTTGAATATAGAG
GAAAGCAAATATACAATTGAGATTGTGAGGAGTGGACAGGGTAGCTACAGATTGAGACTGAATGGATCAC
TTATTGAAGCCAATGTACAAACATTATGTGATGGAGGCCTTTTAATGCAGCTGGATGGAAATAGCCATGT
TATTTATGCTGAAGAAGAAGCGGGTGGTACACGGCTTCTTATTGATGGAAAAACATGCTTGCTACAGAAT
GACCATGATCCGTCAAGGTTATTAGCTGAGACACCCTGCAAACTTCTTCGTTTCTTGATTGCCGATGGTG
CTCATGTTGATGCTGATGTACCATACGCGGAAGTTGAGGTTATGAAGATGTGCATGCCCCTCTTGTCGCC
TGCTGCTGGTGTCATTAATGTTTTGTTGTCTGAGGGCCAGGCGATGCAGGCTGGTGATCTTATAGCGAGA
CTTGATCTCGATGACCCTTCTGCTGTGAAGAGAGCCGAGCCATTTGAAGGATCTTTTCCAGAAATGAGCC
TTCCTATTGCTGCTTCTGGCCAAGTTCACAAAAGATGTGCTGCAAGTTTGAACGCTGCTCGAATGGTCCT
TGCAGGATATGACCATGCGGCCAACAAAGTTGTGCAAGATTTGGTATGGTGCCTTGATACACCTGCTCTT
CCTTTCCTACAATGGGAAGAGCTTATGTCTGTTTTAGCAACTAGACTTCCAAGACGTCTTAAGAGCGAGT
TGGAGGGCAAATACAATGAATACAAGTTAAATGTTGACCATGTGAAGATCAAGGATTTCCCTACCGAGAT
GCTTAGAGAGACAATCGAGGAAAATCTTGCATGTGTTTCCGAGAAGGAAATGGTGACAATTGAGAGGCTT
GTTGACCCTCTGATGAGCCTGCTGAAGTCATACGAGGGTGGGAGAGAAAGCCATGCCCACTTTATTGTCA
AGTCCCTTTTTGAGGAGTATCTCTCGGTTGAGGAACTATTCAGTGATGGCATTCAGTCTGACGTGATTGA
ACGCCTGCGCCTACAATATAGTAAAGACCTCCAGAAGGTTGTAGACATTGTTTTGTCTCACCAGGGTGTG
AGAAACAAAACAAAGCTGATACTCGCGCTCATGGAGAAACTGGTCTATCCAAACCCTGCTGCCTACAGAG
ATCAGTTGATTCGCTTTTCTTCCCTCAACCATAAAAGATATTATAAGTTGGCTCTTAAAGCTAGTGAACT
TCTTGAACAAACCAAGCTCAGCGAACTCCGCACAAGCATTGCAAGGAACCTTTCAGCGCTGGATATGTTC
ACCGAGGAAAAGGCAGATTTCTCCTTGCAAGACAGAAAATTGGCCATTAATGAGAGCATGGGAGATTTAG
TCACTGCCCCACTGCCAGTTGAAGATGCACTTGTTTCTTTGTTTGATTGTACTGATCAAACTCTTCAGCA
GAGAGTGATTCAGACATACATATCTCGATTATACCAGCCTCAACTTGTGAAGGATAGCATCCAGCTGAAA
TATCAGGATTCTGGTGTTATTGCTTTATGGGAATTCACTGAAGGAAATCATGAGAAGAGATTGGGTGCTA
TGGTTATCCTGAAGTCACTAGAATCTGTGTCAACAGCCATTGGAGCTGCTCTAAAGGATGCATCACATTA

TGCAAGCTCTGCGGGCAACACGGTGCATATTGCTTTGTTGGATGCTGATACCCAACTGAATACAACTGAA
GATAGTGGTGATAATGACCAAGCTCAAGACAAGATGGATAAACTTTCTTTTGTACTGAAACAAGATGTTG
TCATGGCTGATCTACGTGCTGCTGATGTCAAGGTTGTTAGTTGCATTGTTCAAAGAGATGGAGCAATCAT
GCCTATGCGCCGTACCTTCCTCTTGTCAGAGGAAAAACTTTGTTACGAGGAAGAGCCGATTCTTCGGCAT
GTGGAGCCTCCACTTTCTGCACTTCTTGAGTTGGATAAATTGAAAGTGAAAGGATACAATGAGATGAAGT
ATACACCGTCACGTGATCGTCAGTGGCATATATACACACTTAGAAATACTGAAAATCCAAAAATGCTGCA
CAGGGTATTTTTCCGAACACTTGTCAGACAACCCAGTGCAGGCAACAGGTTTACATCAGACCATATCACT
GATGTTGAAGTAGGACACGCAGAGGAACCTCTTTCATTTACTTCAAGCAGCATATTAAAATCGTTGAAGA
TTGCTAAAGAAGAATTGGAGCTTCACGCGATCAGGACTGGCCATTCTCATATGTACTTGTGCATATTGAA
AGAGCAAAAGCTTCTTGACCTTGTTCCTGTTTCAGGGAACACTGTTGTGGATGTTGGTCAAGATGAAGCT
ACTGCATGCTCTCTTTTGAAAGAAATGGCTTTAAAGATACATGAACTTGTTGGTGCAAGAATGCATCATC
TTTCTGTATGCCAGTGGGAAGTGAAACTTAAGTTGGTGAGCGATGGGCCTGCCAGTGGTAGCTGGAGAGT
TGTAACAACCAATGTTACTGGTCACACCTGCACTGTGGATATCTACCGGGAGGTCGAAGATACAGAATCA
CAGAAACTAGTATACCACTCCACCGCATTGTCATCTGGTCCTTTGCATGGTGTTGCACTGAATACTTCGT
ATCAGCCTTTGAGTGTTATTGATTTAAAACGTTGCTCTGCCAGGAACAACAAAACTACATACTGCTATGA
TTTTCCATTGACATTTGAAGCTGCAGTGCAGAAGTCGTGGTCTAACATTTCCAGTGAAAACAACCAATGT
TATGTTAAAGCGACAGAGCTTGTGTTTGCTGAAAAGAATGGGTCGTGGGCACTCCTATAATTCCTATGC
AGCGTGCTGCTGGGCTGAATGACATTGGTATGGTAGCCTGGATCTTGGACATGTCCACTCCTGAATTTCC
CAGCGGCAGACAGATCATTGTTATCGCAAATGATATTACATTTAGAGCTGGATCATTTGGCCCAAGGGAA
GATGCATTTTTCGAAGCTGTAACCAACCTGGCTTGTGAGAAGAAGCTTCCACTTATCTACTTGGCTGCAA
ACTCTGGTGCTCGGATTGGCATTGCTGATGAAGTAAAATCTTGCTTCCGTGTTGGATGGACTGATGATAG
CAGCCCTGAACGTGGATTTAGGTACATTTATATGACTGACGAAGACCATGATCGTATTGGCTCTTCAGTT
ATAGCACACAAGATGCAGCTAGATAGTGGCGAGATCAGGTGGGTTATTGATTCTGTTGTGGGAAAAGAGG
ATGGACTAGGTGTGGAGAACATACATGGAAGTGCTGCTATTGCCAGTGCCTATTCTAGGGCGTACGAGGA
GACATTTACACTTACATTCGTTACTGGACGAACTGTTGGAATCGGAGCCTATCTTGCTCGACTTGGCATA
CGGTGCATACAGCGTATTGACCAGCCCATTATTTTGACCGGGTTTTCTGCCCTGAACAAGCTTCTTGGGC
GGGAGGTGTACAGCTCCCACATGCAGTTGGGTGGTCCCAAAATCATGGCGACGAATGGTGTTGTCCATCT
GACTGTTCCAGATGACCTTGAAGGTGTTTCTAATATATTGAGGTGGCTCAGCTATGTTCCTGCAAACATT
GGTGGACCTCTTCCTATTACAAAATCTTTGGACCCAATAGACAGACCCGTTGCATACATCCCTGAGAATA
CATGTGATCCTCGTGCAGCCATCAGTGGCATTGATGACAGCCAAGGGAAATGGTTGGGTGGCATGTTTGA
CAAAGACAGTTTTGTGGAGACATTTGAAGGATGGGCGAAGACAGTAGTTACTGGCAGAGCAAAACTTGGA
GGGATTCCTGTTGGTGTTATAGCTGTGGAGACACAGACCATGATGCAGCTCGTCCCCGCTGATCCAGGCC
AGCCTGATTCCCACGAGCGGTCTGTTCCTCGTGCTGGGCAAGTTTGGTTTCCAGATTCTGCTACCAAGAC
AGCGCAGGCGATGTTGGACTTCAACCGTGAAGGATTACCTCTGTTCATACTTGCTAACTGGAGAGGCTTC
TCTGGAGGGCAAAGAGATCTTTTTGAAGGAATTCTGCAGGCTGGGTCAACAATTGTTGAGAACCTTAGGA
CATACAATCAGCCTGCCTTTGTATATATCCCCAAGGCTGCAGAGCTACGTGGAGGAGCCTGGGTCGTGAT
TGATAGCAAGATAAACCCAGATCGCATCGAGTGCTATGCTGAGAGGACTGCAAAGGGTAATGTTCTCGAA
CCTCAAGGGTTGATTGAGATCAAGTTCAGGTCAGAGGAACTCAAAGAATGCATGGGTAGGCTTGATCCAG
AATTGATAGATCTGAAAGCAAGACTCCAGGGAGCAAATGGAAGCCTATCTGATGGAGAATCCCTTCAGAA
GAGCATAGAAGCTCGGAAGAAACAGTTGCTGCCTCTGTACACCCAAATCGCGGTACGTTTTGCGGAATTG
CACGACACTTCCCTTAGAATGGCTGCTAAAGGTGTGATCAGGAAAGTTGTAGACTGGGAAGACTCTCGGT
CTTTCTTCTACAAGAGATTACGGAGGAGGCTATCCGAGGACGTTCTGGCAAAGGAGATTAGAGGTGTAAT
TGGTGAGAAGTTTCCTCACAAATCAGCGATCGAGCTGATCAAGAAATGGTACTTGGCTTCTGAGGCAGCT
GCAGCAGGAAGCACCGACTGGGATGACGACGATGCTTTTGTCGCCTGGAGGGAGAACCCTGAAAACTATA
AGGAGTATATCAAAGAGCTTAGGGCTCAAAGGGTATCTCGGTTGCTCTCAGATGTTGCAGGCTCCAGTTC
GGATTTACAAGCCTTGCCGCAGGGTCTTTCCATGCTACTAGATAAGATGGATCCCTCTAAGAGAGCACAG
TTTATCGAGGAGGTCATGAAGGTCCTGAAATGA

FIGURE 15B

>CAC84161_Alopecurus myosuroides (black-grass)
MGSTHLPIVGFNASTTPSLSTLRQINSAAAAFQSSSPSRSSKKKSRRVKSIRDDGDGSVPDPAGHGQSIR
QGLAGIIDLPKEGASAPDVDISHGSEDHKASYQMNGILNESHNGRHASLSKVYEFCTELGGKTPIHSVLV
ANNGMAAAKFMRSVRTWANDTFGSEKAIQLIAMATPEDMRINAEHIRIADQFVEVPGGTNNNNYANVQLI
VEIAERTGVSAVWPGWGHASENPELPDALTAKGIVFLGPPASSMNALGDKVGSALIAQAAGVPTLAWSGS
HVEIPLELCLDSIPEEMYRKACVTTADEAVASCQMIGYPAMIKASWGGGGKGIRKVNNDDEVKALFKQVQ
GEVPGSPIFIMRLASQSRHLEVQLLCDEYGNVAALHSRDCSVQRRHQKIIEEGPVTVAPRETVKELEQAA
RRLAKAVGYVGAATVEYLYSMETGEYYFLELNPRLQVEHPVTESIAEVNLPAAQVAVGMGIPLWQIPEIR
RFYGMDNGGGYDIWRKTAALATPFNFDEVDSQWPKGHCVAVRITSENPDDGFKPTGGKVKEISFKSKPNV
WGYFSVKSGGGIHEFADSQFGHVFAYGETRSAAITSMSLALKEIQIRGEIHTNVDYTVDLLNAPDFRENT
IHTGWLDTRIAMRVQAERPPWYISVVGGALYKTITTNAETVSEYVSYLIKGQIPPKHISLVHSTISLNIE
ESKYTIEIVRSGQGSYRLRLNGSLIEANVQTLCDGGLLMQLDGNSHVIYAEEEAGGTRLLIDGKTCLLQN
DHDPSRLLAETPCKLLRFLIADGAHVDADVPYAEVEVMKMCMPLLSPAAGVINVLLSEGQAMQAGDLIAR
LDLDDPSAVKRAEPFEGSFPEMSLPIAASGQVHKRCAASLNAARMVLAGYDHAANKVVQDLVWCLDTPAL
PFLQWEELMSVLATRLPRRLKSELEGKYNEYKLNVDHVKIKDFPTEMLRETIEENLACVSEKEMVTIERL
VDPLMSLLKSYEGGRESHAHFIVKSLFEEYLSVEELFSDGIQSDVIERLRLQYSKDLQKVVDIVLSHQGV
RNKTKLILALMEKLVYPNPAAYRDQLIRFSSLNHKRYYKLALKASELLEQTKLSELRTSIARNLSALDMF
TEEKADFSLQDRKLAINESMGDLVTAPLPVEDALVSLFDCTDQTLQQRVIQTYISRLYQPQLVKDSIQLK
YQDSGVIALWEFTEGNHEKRLGAMVILKSLESVSTAIGAALKDASHYASSAGNTVHIALLDADTQLNTTE
DSGDNDQAQDKMDKLSFVLKQDVVMADLRAADVKVVSCIVQRDGAIMPMRRTFLLSEEKLCYEEEPILRH
VEPPLSALLELDKLKVKGYNEMKYTPSRDRQWHIYTLRNTENPKMLHRVFFRTLVRQPSAGNRFTSDHIT
DVEVGHAEEPLSFTSSSILKSLKIAKEELELHAIRTGHSHMYLCILKEQKLLDLVPVSGNTVVDVGQDEA
TACSLLKEMALKIHELVGARMHHLSVCQWEVKLKLVSDGPASGSWRVVTTNVTGHTCTVDIYREVEDTES
QKLVYHSTALSSGPLHGVALNTSYQPLSVIDLKRCSARNNKTTYCYDFPLTFEAAVQKSWSNISSENNQC
YVKATELVFAEKNGSWGTPIIPMQRAAGLNDIGMVAWILDMSTPEFPSGRQIIVIANDITFRAGSFGPRE
DAFFEAVTNLACEKKLPLIYLAANSGARIGIADEVKSCFRVGWTDDSSPERGFRYIYMTDEDHDRIGSSV
IAHKMQLDSGEIRWVIDSVVGKEDGLGVENIHGSAAIASAYSRAYEETFTLTFVTGRTVGIGAYLARLGI
RCIQRIDQPIILTGFSALNKLLGREVYSSHMQLGGPKIMATNGVVHLTVPDDLEGVSNILRWLSYVPANI
GGPLPITKSLDPIDRPVAYIPENTCDPRAAISGIDDSQGKWLGGMFDKDSFVETFEGWAKTVVTGRAKLG
GIPVGVIAVETQTMMQLVPADPGQPDSHERSVPRAGQVWFPDSATKTAQAMLDFNREGLPLFILANWRGF
SGGQRDLFEGILQAGSTIVENLRTYNQPAFVYIPKAAELRGGAWVVIDSKINPDRIECYAERTAKGNVLE
PQGLIEIKFRSEELKECMGRLDPELIDLKARLQGANGSLSDGESLQKSIEARKKQLLPLYTQIAVRFAEL
HDTSLRMAAKGVIRKVVDWEDSRSFFYKRLRRRLSEDVLAKEIRGVIGEKFPHKSAIELIKKWYLASEAA
AAGSTDWDDDDAFVAWRENPENYKEYIKELRAQRVSRLLSDVAGSSSDLQALPQGLSMLLDKMDPSKRAQ
FIEEVMKVLK

FIGURE 16A

>EU660897_Aegilops tauschii (jointed goatgrass)
ATGGGATCCACACATTTGCCCATTGTCGGCCTTAATGCCTCGACAACACCATCGCTATCCACTATTCGCCCGGTAAA
TTCAGCCGGTGCTGCATTCCAACCATCTGCCCCTTCTAGAACCTCCAAGAAGAAAAGTCGTCGTGTTCAGTCATTAA
GGGATGGAGGCGATGGAGGCGTGTCAGACCCTAACCAGTCTATTCGCCAAGGTCTTGCCGGCATCATTGACCTCCCA
AAGGAGGGCACATCAGCTCCGGAAGTGGATATTTCACATGGGTCCGAAGAACCCAGGGGCTCCTACCAAATGAATGG
GATACTGAATGAAGCACATAATGGGAGGCATGCTTCGCTGTCTAAGGTTGTCGAATTTTGTATGGCATTGGGCGGCA
AAACACCAATTCATAGTGTATTAGTTGCGAACAATGGAATGGCAGCAGCTAAGTTCATGCGGAGTGTCCGAACATGG
GCTAATGAAACATTTGGGTCAGAGAAGGCAATTCAGTTGATAGCTATGGCTACTCCAGAAGACATGAGGATAAATGC
AGAGCACATTAGAATTGCTGATCAATTTGTTGAAGTACCCGGTGGAACAAACAATAACAACTATGCAAATGTCCAAC
TCATAGTGGAGATAGCAGTGAGAACCGGTGTTTCTGCTGTTTGGCCTGGTTGGGGCCATGCATCTGAGAATCCTGAA
CTTCCAGATGCACTAAATGCAAACGGAATTGTTTTTCTTGGGCCACCATCATCATCAATGAACGCACTAGGTGACAA
GGTTGGTTCAGCTCTCATTGCTCAAGCAGCAGGGGTTCCGACTCTTCCTTGGAGTGGATCACAGGTGGAAATTCCAT
TAGAAGTTTGTTTGGACTCGATACCTGCGGATATGTATAGGAAAGCTTGTGTTAGTACTACGGAGGAAGCACTTGCG
AGTTGTCAGATGATTGGGTATCCAGCCATGATTAAAGCATCATGGGGTGGTGGTGGTAAAGGGATCCGAAAGGTTAA
TAACGACGATGATGTCAGAGCACTGTTTAAGCAAGTGCAAGGTGAAGTTCCTGGCTCCCCAATATTTATCATGAGAC
TTGCATCTCAGAGTCGACATCTTGAAGTTCAGTTGCTTTGTGATCAATATGGCAATGTAGCTGCGCTTCACAGTCGT
GACTGCAGTGTGCAACGGCGACACCAAAAGATTATTGAGGAAGGACCAGTTACTGTTGCTCCTCGCGAGACAGTGAA
AGAGCTAGAGCAAGCAGCAAGGAGGCTTGCTAAGGCTGTGGGTTATGTTGGTGCTGCTACTGTTGAATATCTCTACA
GCATGGAGACTGGTGAATACTATTTTCTGGAACTTAATCCACGGTTGCAGGTTGAGCATCCAGTCACCGAGTGGATA
GCTGAAGTAAACTTGCCTGCAGCTCAAGTTGCAGTTGGAATGGGTATACCCCTTTGGCAGGTTCCAGAGATCAGACG
TTTCTATGGAATGGACAATGGAGGAGGCTATGACATTTGGAGGAAAACAGCAGCTCTTGCTACCCCATTTAACTTTG
ATGAAGTGGATTCTCAATGGCCAAAGGGTCATTGTGTAGCAGTTAGGATAACCAGTGAGGATCCAGATGACGGATTC
AAGCCTACCGGTGGAAAAGTAAAGGAGATCAGTTTTAAAAGCAAGCCAAATGTTTGGGCCTATTTCTCTGTTAAGTC
CGGTGGAGGCATTCATGAATTTGCTGATTCTCAGTTTGGACATGTTTTTGCATATGGAGTGTCTAGAGCAGCAGCAA
TAACCAACATGTCTCTTGCGCTAAAAGAGATTCAAATTCGTGGAGAAATTCATTCAAATGTTGATTACACAGTTGAT
CTCTTGAATGCCTCAGACTTCAAAGAAAACAGGATTCATACTGGCTGGCTGGATAACAGAATAGCAATGCGAGTCCA
AGCTGAGAGACCTCCGTGGTATATTTCAGTGGTTGGAGGAGCTCTATATAAAACAATAACGAGCAACACAGACACTG
TTTCTGAATATGTTAGCTATCTCGTCAAGGGTCAGATTCCACCGAAGCATATATCCCTTGTCCATTCAACTGTTTCT
TTGAATATAGAGGAAAGCAAATATACAATTGAAACTATAAGGAGCGGACAGGGTAGCTACAGATTGCGAATGAATGG
ATCAGTTATTGAAGCAAATGTCCAAACATTATGTGATGGTGGACTTTTAATGCAGTTGGATGGAAACAGCCATGTAA
TTTATGCTGAAGAAGAGGCCGGTGGTACACGGCTTCTAATTGATGGAAAGACATGCTTGTTACAGAATGATCACGAT
CCTTCAAGGTTATTAGCTGAGACACCCTGCAAACTTCTTCGTTTCTTGGTTGCCGATGGTGCTCATGTTGAAGCTGA
TGTACCATATGCGGAAGTTGAGGTTATGAAGATGTGCATGCCCCTCTTGTCACCTGCTGCTGGTGTCATTAATGTTT
TGTTGTCTGAGGGCCAGCCTATGCAGGCTGGTGATCTTATAGCAAGACTTGATCTTGATGACCCTTCTGCTGTGAAG
AGAGCTGAGCCGTTTAACGGATCTTTCCCAGAAATGAGCCTTCCTATTGCTGCTTCTGGCCAAGTTCACAAAAGATG
TGCCACAAGCTTGAATGCTGCTCGGATGGTCCTTGCAGGATATGATCACCCGATCAACAAAGTTGTACAAGATCTGG
TATCCTGTCTAGATGCTCCTGAGCTTCCTTTCCTACAATGGGAAGAGCTTATGTCTGTTTTAGCAACTAGACTTCCA
AGGCTTCTTAAGAGCGAGTTGGAGGGTAAATACAGTGAATATAAGTTAAATGTTGGCCATGGAAAGAGCAAGGATTT
CCCTTCCAAGATGCTAAGAGAGATAATCGAGGAAAATCTTGCACATGGTTCTGAGAAGGAAATTGCTACAAATGAGA
GGCTTGTTGAGCCTCTTATGAGCCTACTGAAGTCATATGAGGGTGGCAGAGAAAGCCATGCACACTTTATTGTGAAG
TCCCTTTTCGAGGACTATCTCTCGGTTGAGGAACTATTCAGTGATGGCATTCAGTCTGATGTGATTGAACGCCTGCG
CCAACAACATAGTAAAGATCTCCAGAAGGTTGTAGACATTGTGTTGTCTCACCAGGGTGTGAGAAACAAAACTAAGC
TGATACTAACACTCATGGAGAAACTGGTCTATCCAAACCCTGCTGCCTACAAGGATCAGTTGACTCGCTTTTCCTCC
CTCAATCACAAAAGATATTATAAGTTGGCCCTTAAAGCTAGCGAGCTTCTTGAACAAACCAAGCTTAGTGAGCTCCG
CACAAGCATTGCAAGGAGCCTTTCAGAACTTGAGATGTTTACTGAAGAAAGGACGGCCATTAGTGAGATCATGGGAG
ATTTAGTGACTGCCCCACTGCCAGTTGAAGATGCACTGGTTTCTTTGTTTGATTGTAGTGATCAAACTCTTCAGCAG
AGGGTGATCGAGACGTACATATCTCGATTATACCAGCCTCATCTTGTCAAGGATAGTATCCAGCTGAAATATCAGGA
ATCTGGTGTTATTGCTTTATGGGAATTCGCTGAAGCGCATTCAGAGAAGAGATTGGGTGCTATGGTTATTGTGAAGT
CGTTAGAATCTGTATCAGCAGCAATTGGAGCTGCACTAAAGGGTACATCACGCTATGCAAGCTCTGAGGGTAACATA
ATGCATATTGCTTTATTGGGTGCTGATAATCAAATGCATGGAACTGAAGACAGTGGTGATAACGATCAAGCTCAAGT
CAGGATAGACAAACTTTCTGCGACACTGGAACAAAATACTGTCACAGCTGATCTCCGTGCTGCTGGTGTGAAGGTTA
TTAGTTGCATTGTTCAAAGGGATGGAGCACTCATGCCTATGCGCCATACCTTCCTCTTGTCGGATGAAAAGCTTTGT
TATGAGGAAGAGCCGGTTCTCCGGCATGTGGAGCCTCCTCTTTCTGCTCTTCTTGAGTTGGGTAAGTTGAAAGTGAA
AGGATACAATGAGGTGAAGTATACACCGTCACGTGATCGTCAGTGGAACATATACACACTTAGAAATACAGAGAACC

CCAAAATGTTGCACAGGGTGTTTTTCCGAACTCTTGTCAGGCAACCCGGTGCTTCCAACAAATTCACATCAGGCAAC
ATCAGTGATGTTGAAGTGGGAGGAGCTGAGGAATCTCTTTCATTTACATCGAGCAGCATATTAAGATCGCTGATGAC
TGCTATAGAAGAGTTGGAGCTTCACGCGATTAGGACAGGTCACTCTCATATGTTTTTGTGCATATTGAAAGAGCAAA
AGCTTCTTGATCTTGTTCCCGTTTCAGGGAACAAAGTTGTGGATATTGGCCAAGATGAAGCTACTGCATGCTTGCTT
CTGAAAGAAATGGCTCTACAGATACATGAACTTGTGGGTGCAAGGATGCATCATCTTTCTGTATGCCAATGGGAGGT
GAAACTTAAGTTGGACAGCGATGGGCCTGCCAGTGGTACCTGGAGAGTTGTAACAACCAATGTTACTAGTCACACCT
GCACTGTGGATATCTACCGTGAGGTTGAAGATACAGAATCACAGAAACTAGTGTACCACTCTGCTCCATCGTCATCT
GGTCCTTTGCATGGCGTTGCACTGAATACTCCATATCAGCCTTTGAGTGTTATTGATCTGAAACGTTGCTCCGCTAG
AAATAACAGAACTACATACTGCTATGATTTTCCGTTGGCATTTGAAACTGCAGTGCAGAAGTCATGGTCTAACATTT
CTAGTGACACTAACCGATGTTATGTTAAAGCGACGGAGCTGGTGTTTGCTCACAAGAACGGGTCATGGGGCACTCCT
GTAATTCCTATGGAGCGTCCTGCTGGGCTCAATGACATTGGTATGGTAGCTTGGATCTTGGACATGTCCACTCCTGA
ATATCCCAATGGCAGGCAGATTGTTGTCATCGCAAATGATATTACTTTTAGAGCTGGATCGTTTGGTCCAAGGGAAG
ATGCATTTTTTGAAACTGTTACCAACCTAGCTTGTGAGAGGAAGCTTCCTCTCATCTACTTGGCAGCAAACTCTGGT
GCTCGGATCGGCATAGCAGATGAAGTAAAATCTTGCTTCCGTGTTGGATGGTCTGATGATGGCAGCCCTGAACGTGG
GTTTCAATATATTTATCTGACTGAAGAAGACCATGCTCGTATTAGCGCTTCTGTTATAGCGCACAAGATGCAGCTTG
ATAATGGTGAAATTAGGTGGGTTATTGATTCTGTTGTAGGGAAGGAGGATGGGCTAGGTGTGGAGAACATACATGGA
AGTGCTGCTATTGCCAGTGCCTATTCTAGGGCCTATGAGGAGACATTTACGCTTACATTTGTGACTGGAAGGACTGT
TGGAATAGGAGCATATCTTGCTCGACTTGGCATACGGTGCATTCAGCGTACTGACCAGCCCATTATCCTAACTGGGT
TCTCTGCCTTGAACAAGCTTCTTGGCCGGGAAGTGTACAGCTCCCACATGCAGTTGGGTGGCCCCAAAATTATGGCC
ACAAACGGTGTTGTCCATCTGACAGTTTCAGATGACCTTGAAGGTGTATCTAATATATTGAGGTGGCTCAGCTATGT
TCCTGCCAACATTGGTGGACCTCTTCCTATTACAAAATCTTTGGACCCACCTGACAGACCCGTTGCTTACATCCCTG
AGAATACATGTGATCCTCGTGCAGCCATCAGTGGCATTGATGATAGCCAAGGGAAATGGTTGGGGGGTATGTTCGAC
AAAGACAGTTTTGTGGAGACATTTGAAGGATGGGCGAAGTCAGTAGTTACTGGCAGAGCGAAACTCGGAGGGATTCC
GGTGGGTGTTATAGCTGTGGAGACACAGACTATGATGCAGCTCATCCCTGCTGATCCAGGTCAGCTTGATTCCCATG
AGCGGTCTGTTCCTCGTGCTGGGCAAGTCTGGTTTCCAGATTCAGCTACTAAGACAGCGCAGGCAATGCTGGACTTC
AACCGTGAAGGATTACCTCTGTTCATCCTTGCTAACTGGAGAGGCTTCTCTGGTGGGCAAAGAGATCTTTTTGAAGG
AATCCTTCAGGCTGGGTCAACAATTGTTGAGAACCTTAGGACATACAATCAGCCTGCCTTTGTATATATCCCCAAGG
CTGCAGAGCTACGTGGAGGGGCTTGGGTCGTGATTGATAGCAAGATAAATCCAGATCGCATTGAGTTCTATGCTGAG
AGGACTGCAAAGGGCAATGTTCTTGAACCTCAAGGGTTGATTGAGATCAAGTTCAGGTCAGAGGAACTCCAAGAGTG
CATGGGCAGGCTTGACCCAGAATTGATAAATTTGAAGGCAAAACTCCTGGGAGCAAAGCATGAAAATGGAAGTCTAT
CTGAGTCAGAATCCCTTCAGAAGAGCATAGAAGCCCGGAAGAAACAGTTGTTGCCTTTGTATACTCAAATTGCGGTA
CGGTTCGCTGAATTGCATGACACTTCCCTTAGAATGGCTGCTAAGGGTGTGATTAAGAAGGTTGTAGACTGGGAAGA
TTCTAGGTCTTTCTTCTACAAGAGATTACGGAGGAGGATATCCGAGGATGTTCTTGCAAAGGAAATTAGAGGTGTAA
GTGGCAAGCAGTTTTCTCACCAATCGGCAATCGAGCTGATCCAGAAATGGTACTTGGCCTCTAAGGGAGCTGAAACG
GGAAACACTGAATGGGATGATGACGATGCTTTTGTTGCCTGGAGGGAAAACCCTGAAAACTACCAGGAGTATATCAA
AGAACTCAGGGCTCAAAGGGTATCTCAGTTGCTCTCAGATGTTGCAGACTCCAGTCCAGATCTAGAAGCCTTGCCAC
AGGGTCTTTCTATGCTACTAGAGAAGATGGATCCCTCAAGGAGAGCACAGTTTGTTGAGGAAGTCAAGAAGGCCCTT
AAATGA

FIGURE 16B

>ACD46679_Aegilops tauschii (jointed goatgrass)
MGSTHLPIVGLNASTTPSLSTIRPVNSAGAAFQPSAPSRTSKKKSRRVQSLRDGGDGGVSDPNQSIRQGL
AGIIDLPKEGTSAPEVDISHGSEEPRGSYQMNGILNEAHNGRHASLSKVVEFCMALGGKTPIHSVLVANN
GMAAAKFMRSVRTWANETFGSEKAIQLIAMATPEDMRINAEHIRIADQFVEVPGGTNNNNYANVQLIVEI
AVRTGVSAVWPGWGHASENPELPDALNANGIVFLGPPSSSMNALGDKVGSALIAQAAGVPTLPWSGSQVE
IPLEVCLDSIPADMYRKACVSTTEEALASCQMIGYPAMIKASWGGGGKGIRKVNNDDDVRALFKQVQGEV
PGSPIFIMRLASQSRHLEVQLLCDQYGNVAALHSRDCSVQRRHQKIIEEGPVTVAPRETVKELEQAARRL
AKAVGYVGAATVEYLYSMETGEYYFLELNPRLQVEHPVTEWIAEVNLPAAQVAVGMGIPLWQVPEIRRFY
GMDNGGGYDIWRKTAALATPFNFDEVDSQWPKGHCVAVRITSEDPDDGFKPTGGKVKEISFKSKPNVWAY
FSVKSGGGIHEFADSQFGHVFAYGVSRAAAITNMSLALKEIQIRGEIHSNVDYTVDLLNASDFKENRIHT
GWLDNRIAMRVQAERPPWYISVVGGALYKTITSNTDTVSEYVSYLVKGQIPPKHISLVHSTVSLNIEESK
YTIETIRSGQGSYRLRMNGSVIEANVQTLCDGGLLMQLDGNSHVIYAEEEAGGTRLLIDGKTCLLQNDHD
PSRLLAETPCKLLRFLVADGAHVEADVPYAEVEVMKMCMPLLSPAAGVINVLLSEGQPMQAGDLIARLDL
DDPSAVKRAEPFNGSFPEMSLPIAASGQVHKRCATSLNAARMVLAGYDHPINKVVQDLVSCLDAPELPFL
QWEELMSVLATRLPRLLKSELEGKYSEYKLNVGHGKSKDFPSKMLREIIEENLAHGSEKEIATNERLVEP
LMSLLKSYEGGRESHAHFIVKSLFEDYLSVEELFSDGIQSDVIERLRQQHSKDLQKVVDIVLSHQGVRNK
TKLILTLMEKLVYPNPAAYKDQLTRFSSLNHKRYYKLALKASELLEQTKLSELRTSIARSLSELEMFTEE
RTAISEIMGDLVTAPLPVEDALVSLFDCSDQTLQQRVIETYISRLYQPHLVKDSIQLKYQESGVIALWEF
AEAHSEKRLGAMVIVKSLESVSAAIGAALKGTSRYASSEGNIMHIALLGADNQMHGTEDSGDNDQAQVRI
DKLSATLEQNTVTADLRAAGVKVISCIVQRDGALMPMRHTFLLSDEKLCYEEEPVLRHVEPPLSALLELG
KLKVKGYNEVKYTPSRDRQWNIYTLRNTENPKMLHRVFFRTLVRQPGASNKFTSGNISDVEVGGAEESLS
FTSSSILRSLMTAIEELELHAIRTGHSHMFLCILKEQKLLDLVPVSGNKVVDIGQDEATACLLLKEMALQ
IHELVGARMHHLSVCQWEVKLKLDSDGPASGTWRVVTTNVTSHTCTVDIYREVEDTESQKLVYHSAPSSS
GPLHGVALNTPYQPLSVIDLKRCSARNNRTTYCYDFPLAFETAVQKSWSNISSDTNRCYVKATELVFAHK
NGSWGTPVIPMERPAGLNDIGMVAWILDMSTPEYPNGRQIVVIANDITFRAGSFGPREDAFFETVTNLAC
ERKLPLIYLAANSGARIGIADEVKSCFRVGWSDDGSPERGFQYIYLTEEDHARISASVIAHKMQLDNGEI
RWVIDSVVGKEDGLGVENIHGSAAIASAYSRAYEETFTLTFVTGRTVGIGAYLARLGIRCIQRTDQPIIL
TGFSALNKLLGREVYSSHMQLGGPKIMATNGVVHLTVSDDLEGVSNILRWLSYVPANIGGPLPITKSLDP
PDRPVAYIPENTCDPRAAISGIDDSQGKWLGGMFDKDSFVETFEGWAKSVVTGRAKLGGIPVGVIAVETQ
TMMQLIPADPGQLDSHERSVPRAGQVWFPDSATKTAQAMLDFNREGLPLFILANWRGFSGGQRDLFEGIL
QAGSTIVENLRTYNQPAFVYIPKAAELRGGAWVVIDSKINPDRIEFYAERTAKGNVLEPQGLIEIKFRSE
ELQECMGRLDPELINLKAKLLGAKHENGSLSESESLQKSIEARKKQLLPLYTQIAVRFAELHDTSLRMAA
KGVIKKVVDWEDSRSFFYKRLRRRISEDVLAKEIRGVSGKQFSHQSAIELIQKWYLASKGAETGNTEWDD
DDAFVAWRENPENYQEYIKELRAQRVSQLLSDVADSSPDLEALPQGLSMLLEKMDPSRRAQFVEEVKKAL
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