BRIEF SUMMARY

[0005] This disclosure is based, at least in part, on the discovery that disrupting a gene that encodes the enzyme Poly (adenosine 5'-diphosphate (ADP)-Ribose) Polymerase (PARP), *e.g.,* PARP2, in a plant, *e.g.,* can alter its developmental cycle in a way that is ideal for confined and/or controlled growth*, e.g.,* in spaceflight applications or other environments. Such genetically modified plants can have minimal amounts of leaves and/or develop fruit in rapid progression. Further, the plants can have several traits that make them ideal for cultivation in confined, controlled, vertical, heterotrophic, and/or automated, e.g., those implementing robotics for crop management and/or harvest, environments when compared to widltype plants: 1) small size, 2) small amount of non-edible biomass produced, 3) the ability to produce fruit faster, 4) the ability to produce fruit more consistent in weight and/or size across various harvest times throughout each plant's life cycle, 5) the ability to yield the same or close to the same amount of fruit, 6) less utilization of water and/or vertical and/or horizontal space, e.g., due to any of the aforementioned, and/or 7) the ability to produce more seed.

[0006] These desirable traits, which are referred to herein as "SPACE", which can stand for "Small Plants for spACe Expeditions" or "Small Plants for Agriculture in Confined Environments" or "Small Plants for Agriculture in Controlled Environments" or "Small Plants for Agriculturally Controlled Environments". Plants of a specific line with these desirable traits are referred to herein as "SPACE", "SPACE Tomatoes", "M#", e.g., "M3", or "PARP2 Mutant". These SPACE traits can be induced by the addition of chemical inhibitors or in some examples, by gene disruption. Most other mutations that make plants dwarfs largely keep the proportion of leafy, un-edible material to edible fruit the same. NASA has previously investigated several dwarf tomatoes for cultivation during spaceflight, but none have been this extreme. In addition to being small, the SPACE trait forces the plant quickly through developmental cycles to produce fruit without the necessity to develop the whole plant. This results in profoundly small plants that produce fruit that is a high fraction of their biomass. Introducing the SPACE trait into plants such as tomato, potato, citrus, strawberries, pepper, and blueberries expands the range of fresh produce that can be cultivated in controlled environment agriculture systems. In some examples, *e.g.,* in genetically modified tomato, the plants have fewer leaves and flowers, and develop fruit in a faster progression. In some examples, the plants additionally produce larger numbers of seed, *e.g.,* a 2- to 3-fold increase, compared to wild type plants.

[0007] Thus, provided herein are plants genetically modified to disrupt the PARP2 gene and inhibit expression of the protein.

[0007a] In one aspect, provided herein is a method of obtaining a plant that has reduced non-edible biomass compared to a counterpart control plant, the method comprising disrupting expression of an endogenous Poly (adenosine 5'-diphosphate (ADP)-Ribose) Polymerase 2 (PARP2) gene of the plant; and selecting a plant that has a reduction in the proportion of non-edible biomass as measured by an increase in harvest index compared to the counterpart control plant; wherein the plant is a tomato plant and the counterpart control plant is a tomato plant wherein the PARP2 gene is not disrupted.

[0007b] In another aspect, provided herein is a genetically modified tomato plant obtained by the method provided herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Fig. 1. T1 generation, i.e., first generation after transformation, of mature tomato plants 90 days of age disrupted in the PARP2 gene growing in soil.

[0009] Fig. 2. Tomato plants disrupted in the PARP2 gene growing *in vitro*.

[0010] Fig. 3. Wild-type tomato plants growing *in vitro*.

[0011] Fig. 4. T1 mature wild-type tomato plant growing in soil.

[0012] Fig. 5A-5C. 5A: T2 detection by PCR of Cas9 transgene in tomato plants disrupted in the PARP2 gene; 5B: T2 RT-PCR analysis of *NPTII* gene expression in tomato plants disrupted in the PARP2 gene; 5C: T2 genotyping of tomato plants disrupted in the PARP2 gene.

[0013] Fig. 6A and 6B. 6A: T2 biomass and fruit production of a wild-type tomato plant (Harvest index = 0.60); 6B: T2 biomass and fruit production of wild type (Harvest index = 0.6) and plants disrupted in the PARP2 gene (Harvest index = 0.77).

[0014] Fig. 7. Orthologues of the tomato PARP2 gene present in different plant species.

[0015] Fig. 8. Physical map of the pKEE401 binary vector used to produce plants disrupted in the PARP2 gene.

[0016] Fig. 9. Structural motifs in tomato PARP2 gene.

[0017] Fig. 10A-10C. 10A: T2 population of tomato plants disrupted in the PARP2 gene during flowering and fruiting; 10B: Perspective top view of T3 population of mature tomato plants disrupted in the PARP2 gene during flowering and fruiting; 10C: Perspective side view of T3 population of mature tomato plants disrupted in the PARP2 gene during flowering and fruiting.

[0018] Fig. 11A-11C. 11A: T2 wild type flowering tomato plants; 11B: T2 homozygous tomato plants disrupted in the PARP2 gene showing precocious flowering and fruiting; 10B: Perspective top view of T3 population of mature tomato plants disrupted in the PARP2 gene

WHAT IS CLAIMED IS:

1. A method of obtaining a plant that has reduced non-edible biomass compared to a counterpart control plant, the method comprising disrupting expression of an endogenous Poly (adenosine 5'-diphosphate (ADP)-Ribose) Polymerase 2 (PARP2) gene of the plant; and

selecting a plant that has a reduction in the proportion of non-edible biomass as measured by an increase in harvest index compared to the counterpart control plant;

wherein the plant is a tomato plant and the counterpart control plant is a tomato plant wherein the PARP2 gene is not disrupted.

2. The method of claim 1, wherein the step of disrupting expression of the PARP2 gene comprises introducing an RNA-guided nuclease into the plant, wherein the RNA guides target the PARP2 gene.

3. The method of claim 2, wherein the RNA-guided nuclease is a Cas polypeptide.

4. The method of claim 3, wherein the RNA guided nuclease is a Cas9 polypeptide.

5. A genetically modified tomato plant obtained by the method of any one of claims 1 to 4.