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(54) Title: BIOCONTROL COMPOSITIONS AND METHODS

COMPOUND	% GENE CLUSTER SIMILARITY
FENGYCIN	86
PLIPASTATIN	26
MACROLACTIN H	90
DIFFICIDIN	53
BACILYSIN	100
BACILLIBACTIN	100
SURFACTIN	39
BACILLAENE	100
BUTIROSIDIN A / B	7
RHIZOCTICIN A	6

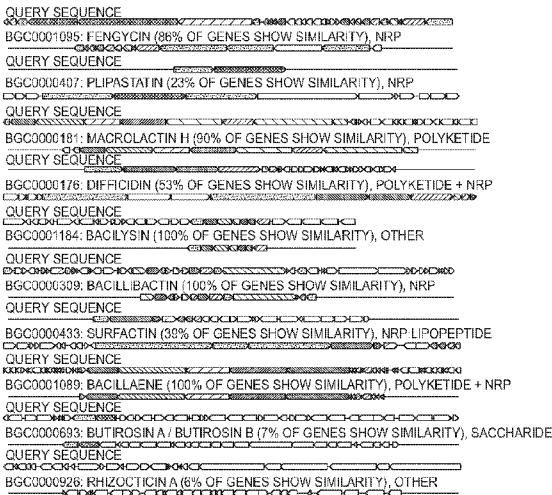


FIG. 1

(57) Abstract: The disclosure provides biocontrol compositions and methods. The biocontrol composition may include a Bacillus amyloliquefaciens strain. The biocontrol composition may include an aqueous solution having a pH in a range from about 6 to about 11. The method may include contacting a plant, a seed, a fruit, a leaf, or soil containing the plant with the biocontrol composition.

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- *with sequence listing part of description (Rule 5.2(a))*

BIOCONTROL COMPOSITIONS AND METHODS

SEQUENCE LISTING

[0001] The instant application contains a Sequence Listing which has been submitted electronically in XML format and is hereby incorporated by reference in its entirety. Said XML copy, created on July 18, 2024, is named 18984-017WO1 Sequence Listing and is 4.2 kilobytes in size

BACKGROUND

[0002] Some pathogens on plants may be a problem. For example, they can cause diseases or other issues with the plants themselves, or with produce. Accordingly, there exists a need for improved methods and compositions to combat plant pathogens.

SUMMARY

[0003] This summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

[0004] An aspect of the present disclosure is a method comprising contacting a plant, a seed, or soil comprising a plant, with a formulation including (i) a *Bacillus amyloliquefaciens* comprising a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1, and/or (ii) with one or more molecules synthesized by said *Bacillus amyloliquefaciens*. The formulation may have a pH in a range from about 6 to about 11. In this aspect, the contacting reduces growth of or kills, one or more pathogenic organisms present on or inside the plant, the seed, or the soil comprising the plant, wherein the one or more pathogenic organisms is selected from the group consisting of a fungus, a bacterium, and a nematode.

[0005] A further aspect of the present disclosure is a formulation comprising a *Bacillus amyloliquefaciens* spore comprising a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1, wherein the formulation has a pH in a range from about

6 to about 11 and comprises viable *Bacillus amyloliquefaciens* after storage at a temperature of from about 18°C to about 25°C or at a temperature of up to about 50°C for at least 14 days.

[0006] An additional aspect of the present disclosure is a method for treating a disease in a plant, a seed, or soil comprising a plant. The method comprises steps of: obtaining a plant, a seed, or soil comprising a plant having a disease; and contacting the plant, the seed, or soil comprising the plant, with a formulation that includes (i) *Bacillus amyloliquefaciens* comprising a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1, and/or (ii) with one or more molecules synthesized by said *Bacillus amyloliquefaciens*. The formulation may have a pH in a range from about 6 to about 11. In this aspect, the contacting reduces growth of or kills, one or more pathogenic organisms present on or inside the plant, the seed, or the soil comprising the plant and responsible for the disease; and the disease is Asian soybean rust, rice blast, brown spot, narrow brown spot, crown rot, sour rot (citrus, post-harvest), olive quick decline syndrome, Pierce's disease (grapes), leaf scorch (almonds, coffee), citrus variegated chlorosis, Black rot, soybean cysts, or root knots.

[0007] Another aspect of the present disclosure is a method for preventing or reducing severity of a disease in a plant, a seed, or soil comprising a plant. The method comprises steps of: obtaining a plant, a seed, or soil comprising a plant at risk for contracting a disease and contacting the plant, the seed, or soil comprising the plant, with a formulation including (i) a *Bacillus amyloliquefaciens* comprising a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1, and/or (ii) with one or more molecules synthesized by said *Bacillus amyloliquefaciens*. The formulation may have a pH in a range from about 6 to about 11. In this aspect, the contacting reduces growth of or kills, one or more pathogenic organisms present on or inside the plant, the seed, or the soil comprising the plant and responsible for the disease; and the disease is Asian soybean rust, rice blast, brown spot, narrow brown spot, crown rot, sour rot (citrus, post-harvest), olive quick decline syndrome, Pierce's disease (grapes), leaf scorch (almonds, coffee), citrus variegated chlorosis, Black rot, soybean cysts, or root knots.

[0008] Any aspect or embodiment described herein can be combined with any other aspect or embodiment as disclosed herein. Other aspects and advantages of the claimed subject matter will be apparent from the following description and the appended claims.

INCORPORATION BY REFERENCE

[0009] All publications, patents, and patent applications mentioned in this specification are herein incorporated by reference to the same extent as if each individual publication, patent, or patent application was specifically and individually indicated to be incorporated by reference.

BRIEF DESCRIPTION OF DRAWINGS

[0010] The novel features of the disclosure are set forth with particularity in the appended claims. A better understanding of the features and advantages of the present disclosure will be obtained by reference to the following detailed description that sets forth illustrative embodiments, in which the principles of the disclosure are utilized, and the accompanying drawings of which:

[0011] FIG. 1 shows the sequence alignments results of gene clusters in the BC17B genome as compared to known *Bacillus* genome sequences in accordance with one or more embodiments.

[0012] FIG. 2 shows digital images of the inhibition of *Xanthomonas campestris* on R2A medium by BC17B as compared to control cells.

[0013] FIG. 3A and FIG. 3B show the tabulated average *Xanthomonas campestris*-related disease severity scores for disc 1 and disc 2, respectively.

[0014] FIG. 4A shows the degree of blackspot control for the three experimental conditions at 25 days post-treatment.

[0015] FIG. 4B show digital images comparing the appearance of PBS-treated lettuce and BC17B-treated lettuce.

- [0016] FIG. 5 is a graph showing the degree of inhibition of wound size and weight achieved by BC17B in peaches with wounds infected by *Botrytis cinerea*.
- [0017] FIG. 6 is a graph showing the incidence of blossom blight in blueberries treated with BC17B.
- [0018] FIG. 7A is a graph showing the incidence of *Botrytis* on grape clusters treated with BC17B.
- [0019] FIG. 7B is a graph showing the severity of *Botrytis* on grape clusters treated with BC17B.
- [0020] FIG. 7C is a graph showing the disease index of *Botrytis* for grape clusters treated with BC17B.
- [0021] FIG. 8A is a graph showing the incidence of Downey Mildew on grape leaves treated with BC17B.
- [0022] FIG. 8B is a graph showing the severity of Downey Mildew on grape leaves treated with BC17B.
- [0023] FIG. 8C is a graph showing the disease index of Downey Mildew for grape leaves treated with BC17B.
- [0024] FIG. 9A is a graph showing the incidence of Powdery Mildew on grape clusters treated with BC17B.
- [0025] FIG. 9B is a graph showing the severity of Powdery Mildew on grape clusters treated with BC17B.
- [0026] FIG. 9C is a graph showing the disease index of Powdery Mildew for grape clusters treated with BC17B.
- [0027] FIG. 10A is a graph showing the incidence of Powdery Mildew on grape leaves treated with BC17B.
- [0028] FIG. 10B is a graph showing the severity of Powdery Mildew on grape leaves treated with BC17B.

- [0029] FIG. 10C is a graph showing the disease index of Powdery Mildew for grape leaves treated with BC17B.
- [0030] FIG. 11 is a graph showing percent (%) disease reduction for cucumbers inoculated with downey mildew spores and treated with BC17B.
- [0031] FIG. 12 show digital images of the inhibition of *Monilinia fructicola* by BC17B.
- [0032] FIG. 13A is a graph showing inhibition of Panama Wilt pseudostem disease caused by *Fusarium oxysporum* for Cavendish bananas treated with *Bacillus amyloliquefaciens* strain BC17B or Propiconazole chemical fungicide.
- [0033] FIG. 13B includes digital images of whole plants and pseudostems of Cavendish bananas treated with *Bacillus amyloliquefaciens* strain BC17B and grown in soil infested with *Fusarium oxysporum*.
- [0034] FIG. 14A includes graphical data showing BC17B colonization in banana plants.
- [0035] FIG. 14B includes digital images of banana root, stem, and leaves, and plates from which data were generated.
- [0036] FIG. 15 is a graph showing *Bacillus amyloliquefaciens* strain BC17B protects blueberry plants against the endophytic bacterial pathogen *Xylella fastidiosa*, where disease was rated based on percent of symptomatic and asymptomatic leaves per plant.
- [0037] FIG. 16 shows weekly disease severity for Pierce's Disease in Grenache grape vines treated with *Bacillus amyloliquefaciens* BC17B.
- [0038] FIG. 17A is a graph showing incidence of Leaf Scorch in almond tree leaves, *Xylella fastidiosa* (Xfa): infected (with Breakthru® adjuvant, Xfa, Brk); infected and treated (Xfa, BC17B, Brk), uninfected but treated with adjuvant as a control (Brk) or uninfected, untreated. BC17B and Breakthru® were applied by foliar spray.
- [0039] FIG. 17B is a graph showing incidence of Leaf Scorch in almond tree leaves, *Xylella fastidiosa subsp. multiplex* (Xfa mpx): infected (with Breakthru® adjuvant, Xfa mpx, Brk); infected and treated (Xfa mpx, BC17B, Brk), uninfected but treated with

adjuvant as a control (Brk) or uninfected, untreated. BC17B and Breakthru® were applied by foliar spray.

[0040] FIG. 17C is a graph showing severity of Leaf Scorch in almond tree leaves, *Xylella fastidiosa* (Xfa): infected (with Breakthru® adjuvant, Xfa, Brk); infected and treated (Xfa, BC17B, Brk), uninfected but treated with adjuvant as a control (Brk) or uninfected, untreated. BC17B and Breakthru® were applied by foliar spray.

[0041] FIG. 17D is a graph showing severity of Leaf Scorch in almond tree leaves, *Xylella fastidiosa subsp. multiplex* (Xfa mpx): infected (with Breakthru® adjuvant, Xfa mpx, Brk); infected and treated (Xfa mpx, BC17B, Brk), uninfected but treated with adjuvant as a control (Brk) or uninfected, untreated. BC17B and Breakthru® were applied by foliar spray.

[0042] FIG. 17E is a graph showing incidence of Leaf Scorch in almond tree leaves, *Xylella fastidiosa* (Xfa): infected (Xfa); infected and treated (Xfa, BC17B), or uninfected, untreated. BC17B was applied by injection.

[0043] FIG. 17F is a graph showing incidence of Leaf Scorch in almond tree leaves, *Xylella fastidiosa subsp. multiplex* (Xfa mpx): infected (Xfa mpx); infected and treated (Xfa mpx, BC17B), or uninfected, untreated. BC17B was applied by injection.

[0044] FIG. 17G is a graph showing severity of Leaf Scorch in almond tree leaves, *Xylella fastidiosa* (Xfa): infected (Xfa); infected and treated (Xfa, BC17B), or uninfected, untreated. BC17B was applied by injection.

[0045] FIG. 17H is a graph showing severity of Leaf Scorch in almond tree leaves, *Xylella fastidiosa subsp. multiplex* (Xfa mpx): infected (Xfa mpx); infected and treated (Xfa mpx, BC17B), or uninfected, untreated. BC17B was applied by injection.

[0046] FIG. 18A is a graph showing the number of colony forming unit per gram (CFU/g) of *Bacillus amyloliquefaciens* BC17B that persisted epiphytically on the stem tissue of almond trees three months after contact.

- [0047] FIG. 18B is a graph showing the number of CFU/g of *Bacillus amyloliquefaciens* BC17B that persisted endophytically on the stem tissue of almond trees three months after contact.
- [0048] FIG. 19 is a graph showing reduction of nematode load in soil treated with *Bacillus amyloliquefaciens* strain BC17B.
- [0049] FIG. 20 is a graph showing long lasting protection of roots from root knot nematodes in cucumber plants treated with *Bacillus amyloliquefaciens* strain BC17B.
- [0050] FIG. 21 is a graph showing the disease index of rice blast for rice treated with *Bacillus amyloliquefaciens* strain BC17B.
- [0051] FIG. 22 is a graph showing the disease index of narrow brown spot for rice treated with *Bacillus amyloliquefaciens* strain BC17B.
- [0052] FIG. 23 is a graph showing the disease index of brown spot for rice treated with *Bacillus amyloliquefaciens* strain BC17B.
- [0053] FIG. 24 is a graph showing the disease index of sheath blight for rice treated with *Bacillus amyloliquefaciens* strain BC17B.
- [0054] FIG. 25A includes graphs showing the mycelial mass diameter and *Mycosphaerella* spore count in banana plants treated with *Bacillus amyloliquefaciens* strain BC17B, or a PBS control.
- [0055] FIG. 25B is a graph showing percent *Mycosphaerella* in BC17B-treated plants relative to a PBS-treated control.
- [0056] FIG. 26A shows the efficacy of different treatments: BC17B; Serenade®, a biological control product; and Tilt®, a chemical control product, at controlling Black Sigatoka on bananas in greenhouses.
- [0057] FIG. 26B shows the standard area under the disease progression curve for different treatments: BC17B; Serenade®, a biological control product; and Tilt®, a chemical control product, at controlling Black Sigatoka on bananas in greenhouses.

- [0058] FIG. 27A is a graph showing disease severity in *Xylella fastidiosa* infection in olive trees treated with BC17B and Breakthru® surfactant.
- [0059] FIG. 27B is a graph showing disease incidence in *Xylella fastidiosa* infection in olive trees treated with *Bacillus amyloliquefaciens* BC17B and Breakthru® surfactant.
- [0060] FIG. 28A shows the average severity scores for evaluation of internal symptoms of Panama Wilt caused by *Fusarium oxysporum*.
- [0061] FIG. 28B shows representative images of cross-sections of banana plants treated with *Bacillus amyloliquefaciens* BC 17B (left) or water (right).
- [0062] FIG. 29 shows digital images of the inhibition of *Penicillium digitatum*, the causative agent of clear rot in citrus, by *Bacillus amyloliquefaciens* BC17B.
- [0063] FIG. 30 is a graph showing the disease rating of soybean plants infected with Asian Soybean Rust, untreated and treated with Proline or BC17B.
- [0064] FIG. 31A is a graph showing the stability of BC17B spores over two-week incubation period at 54°C.
- [0065] FIG. 31B is a digital image of the retained efficacy of BC17B at inhibiting *Botrytis cinerea* in a standard *in vitro* confrontation assay after two weeks incubation at 54°C.

DETAILED DESCRIPTION

- [0066] Numerous organisms can infect plants of agricultural importance, resulting in food rot and food spoilage while the plants are in the field or after being harvested. For example, the fungal pathogen *Botrytis cinerea*, can often be found on fruits, both in the field and at the grocery store. Thus, mitigating loss of harvested plants or food caused by pathogens is highly desirable by those involved in food production and consumption. Chemical and biological based control strategies have previously been developed; however, while such strategies may be effective, the use of these chemical- and biological-based fungicides on food crops can provide unintended side effects, such as higher toxicity, in addition to being undesirable to consumers. Additionally, currently available commercial biocontrol compositions may not provide the desired pathogen or plant specificity or efficacy. Finally,

there may be a significant burden on recording and reporting the applications of synthetic chemical pesticides, which can be burdensome to farmers and growers.

[0067] One or more embodiments herein relate to compositions and methods for reducing growth of or killing pathogenic organisms. For example, embodiment compositions, formulations, and methods described herein are capable of reducing growth or killing pathogenic organism(s) that effect plants of agricultural importance. Compositions and methods disclosed herein can be formulated or adjusted to be used at various points in the production process. For example, compositions can be formulated for use prior to harvest, for example by incorporating the composition into an irrigation line or administration in combination with a fertilizer. Compositions can also be formulated for use post-harvest and/or during processing, packaging, transportation, storage, and commercial display of the produce. Compositions for post-harvest may be sprayed on the harvested produce or used by applying the composition to a packaging material that is used to store or ship the produce. Furthermore, these compositions can show improved efficacy when compared to commercial biocontrol compositions.

[0068] BIOCONTROL MICROBE

[0069] In one aspect, embodiments disclosed herein relate to a biocontrol microbe (or “microbe”) capable of treating, reducing, or killing one or more plant pathogens. A microbe of the disclosure, for example, a *Bacillus amyloliquefaciens* BC17B, may be an engineered or recombinant microbe. The microbe may comprise additional nucleic acids sequences, mutations, or other sequences deviations from a microbe found in nature. The microbe may include a *Bacillus amyloliquefaciens* BC17B strain having a genome in accordance with Deposit Number PTA-127137 in the ATCC® Patent Depository.

[0070] The microbe of one or more embodiments may include a *Bacillus amyloliquefaciens* microbe. The *Bacillus amyloliquefaciens* may be a *Bacillus amyloliquefaciens* BC17B strain (also referred to herein as “BC17”). The *Bacillus amyloliquefaciens* BC17B strain includes a 16S ribosomal RNA (rRNA) sequence of SEQ ID NO: 1. The *Bacillus amyloliquefaciens* microbe may include a 16S rRNA that includes a sequence in accordance with SEQ ID NO: 1. The *Bacillus amyloliquefaciens* may include

a 16S rRNA sequence at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99%, identical to SEQ ID NO: 1. The *Bacillus amyloliquefaciens* may include a 16S rRNA sequence at least 99.1%, 99.2%, 99.3%, 99.4%, 99.5%, 99.6%, 99.7%, 99.8%, or 99.9%, identical to SEQ ID NO: 1. In some embodiments, the *Bacillus amyloliquefaciens* includes a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1. In some embodiments, the sequence of the nucleic acid is 100% identical to SEQ ID NO: 1.

[0071] In some embodiments, a *Bacillus amyloliquefaciens* BC17B strain of the present disclosure, comprises a nucleic acid sequence having a percent sequence identity to SEQ ID NO: 1 and/or SEQ ID NO 2 in a range having a lower limit of any one of 70%, 71%, 72%, 73%, 74%, 75%, 76%, 77%, 78%, 79%, 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 88%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 95.5%, 96%, 96.5%, 97%, 97.5%, 98%, 98.5%, 99%, 99.1%, 99.3%, 99.4%, 99.5%, 99.6%, 99.7%, 99.8%, 99.9%, 99.95%, 99.99%, and 100% and an upper limit of any one of 71%, 72%, 73%, 74%, 75%, 76%, 77%, 78%, 79%, 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 88%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 95.5%, 96%, 96.5%, 97%, 97.5%, 98%, 98.5%, 99%, 99.1%, 99.3%, 99.4%, 99.5%, 99.6%, 99.7%, 99.8%, 99.9%, 99.95%, 99.99%, and 100%, where any lower limit can be paired with any mathematically compatible upper limit. SEQ ID NO: 1 and 2 may be as shown in Table 1.

[0072] Table 1. Sequences of SEQ ID NO: 1 and SEQ ID NO: 2.

SEQ ID NO:	Description	Sequence (5' to 3')
1	BC17B 16S rRNA sequence	TCGAGCGGACAGATGGGAGCTTGCTCCCTGATGTT AGCGGCGGACGGGTGAGTAACACGTGGGTAACT GCCTGTAAGACTGGGATAACTCCGGGAAACCGGG GCTAATACCGGATGGTTGTCTGAACCGCATGGTTC AGACATAAAAGGTGGCTTCGGCTACCACTTACAG ATGGACCCGCGGCGCATTAGCTAGTTGGTGAGGT AACGGCTCACCAAGGCGACGATGCGTAGCCGACC TGAGAGGGTGATCGGCCCACTGGGACTGAGACA CGGCCAGACTCCTACGGGAGGCAGCAGTAGGGA ATCTTCCGCAATGGACGAAAGTCTGACGGAGCAA

		CGCCGCGTGAGTGATGAAGGTTTTTCGGATCGTAA AGCTCTGTTGTTAGGGAAGAACAAGTGCCGTTCA AATAGGGCGGCACCTTGACGGTACCTAACCAGAA AGCCACGGCTAACTACGTGCCAGCAGCCGCGGTA ATACGTAGGTGGCAAGCGTTGTCCGGAATTATTG GGCGTAAAGGGCTCGCAGGCGGTTTTCTTAAGTCT GATGTGAAAGCCCCCGGCTCAACCGGGGAGGGTC ATTGGAAACTGGGGAACCTTGAGTGCAGAAGAGGA GAGTGGAATTCCACGTGTAGCGGTGAAATGCGTA GAGATGTGGAGGAACACCAGTGGCGAAGGCGACT CTCTGGTCTGTAAGTACGCTGAGGAGCGAAAGC GTGGGGAGCGAACAGGATTAGATACCCTGGTAGT CCACGCCGTAAACGATGAGTGCTAAGTGTTAGGG GGTTTCCGCCCCCTTAGTGCTGCAGCTAACGCATTA AGCACTCCGCCTGGGGAGTACGGTCGCAAGACTG AAACTCAAAGGAATTGACGGGGGCCCCGCACAAGC GGTGGAGCATGTGGTTTAATTCTGAAGCAACGCGA AGAACCTTACCAGGTCTTGACATCCTCTGACAATC CTAGAGATAGGACGTCCCCCTTCGGGGGCGAGAGTG ACAGGTGGTGCATGGTTGTCGTCAGCTCGTGTCGT GAGATGTTGGGTAAAGTCCCGCAACGAGCGCAAC CCTTGATCTTAGTTGCCAGCATTTCAGTTGGGCACT CTAAGGTGACTGCCGGTGACAAACCGGAGGAAGG TGGGGATGACGTCAAATCATCATGCCCTTATGAC CTGGGCTACACACGTGCTACAATGGACAGAACAA AGGGCAGCGAAACCGCGAGGTAAAGCCAATCCCA CAAATCTGTTCTCAGTTCGGATCGCAGTCTGCAAC TCGACTGCGTGAAGCTGGAATCGTAGTAATCGC GGATCAGCATGCCGCGGTGAATACGTTCCCGGGC CTTGTACACACCGCCCGTCACACCACGAGAGTTTG TAACACCCGAAGTCGGTGAGGTAACCTT
2	BC17B 16S rRNA sequence	ACGTAGGTGGCAAGCGTTGTCCGGAATTATTGGG CGTAAAGGGCTCGCAGGCGGTTTTCTTAAGTCTGAT GTGAAAGCCCCCGGCTCAACCGGGGAGGGTCATT GGAAACTGGGGAACCTTGAGTGCAGAAGAGGAGA GTGGAATTCCACGTGTAGCGGTGAAATGCGTAGA GATGTGGAGGAACACCAGTGGCGAAGGCGACTCT CTGGTCTGTAAGTACGCTGAGGAGCGAAAGCGT GGGGAGCGAACAG

[0073] In some embodiments, the microbe has one or more gene clusters that are related to the biosynthesis of one or more compounds. In one or more embodiments, the gene clusters are responsible for biosynthesis of known antibiotic compounds and other activities were identified. In some embodiments, the microbe may have a plurality of percent gene cluster similarities to known *Bacillus* genome sequences as described in FIG. 1, which shows example compounds and gene clusters related to the synthesis of these compound found in the microbes of the disclosure. The microbe may include gene clusters having within a certain percentage known to *Bacillus* genome sequences. For example, the microbe of one or more embodiments may have a gene cluster for the production of fengycin having a gene cluster similarity in a range having a lower limit of any one of 75%, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, and 86% similarity to known *Bacillus* genome sequences and an upper limit of any one of 86%, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, and 100% similarity to known *Bacillus* genome sequences, where any lower limit can be paired with any mathematically compatible upper limit. In some embodiments, the microbe includes a gene cluster for the production of fengycin having a similarity of at least 75%, at least 80%, or at least 85% similarity to known *Bacillus* genome sequences.

[0074] The microbe of one or more embodiments may have a gene cluster for the production of plipastatin having a gene cluster similarity in a range having a lower limit of any one of 15%, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, and 26% similarity to known *Bacillus* genome sequences and an upper limit of any one of 26%, 27, 28, 29, 30, 31, 32, 33, 34, and 35% similarity to known *Bacillus* genome sequences, where any lower limit can be paired with any mathematically compatible upper limit. In some embodiments, the microbe includes a gene cluster for the production of plipastatin having a similarity of at least 15%, at least 20%, at least 25%, at least 30%, at least 35%, at least 40%, at least 50%, at least 60%, at least 70%, at least 80%, and at least 90% similarity to known *Bacillus* genome sequences.

[0075] The microbe of one or more embodiments may have a gene cluster for the production of butirosin A and/or butirosin B having a gene cluster similarity in a range having a lower limit of any one of 0%, 1, 2, 3, 4, 5, 6, and 7% similarity to known *Bacillus*

genome sequences and an upper limit of any one of 7%, 7.5, 8, 9, 10, 12, 15, and 20% or greater similarity to known *Bacillus* genome sequences, where any lower limit can be paired with any mathematically compatible upper limit. In some embodiments, the microbe includes a gene cluster for the production of butirosin A and/or butirosin B having a similarity of at least 1%, at least 5%, at least 7%, at least 10%, at least 15%, at least 20%, and at least 25% similarity to known *Bacillus* genome sequences.

[0076] The microbe of one or more embodiments may have a gene cluster for the production of rhizoctin A having a gene cluster similarity in a range having a lower limit of any one of 0%, 1, 2, 3, 4, 5, 5.5, and 6% similarity to known *Bacillus* genome sequences and an upper limit of any one of 6.5%, 7, 7.5, 8, 9, 10, 12, 15, and 20% or greater similarity to known *Bacillus* genome sequences, where any lower limit can be paired with any mathematically compatible upper limit. In some embodiments, the microbe includes a gene cluster for the production of rhizoctin A having a similarity of at least 1%, at least 5%, at least 7%, at least 10%, at least 15%, at least 20%, and at least 25% similarity to known *Bacillus* genome sequences.

[0077] The microbe of one or more embodiments may have a gene cluster for the production of Macrolactin H having a gene cluster similarity in a range having a lower limit of any one of 80%, 81, 82, 83, 84, 85, 86, 87, 88, 89, and 90% similarity to known *Bacillus* genome sequences and an upper limit of any one of 90%, 91, 92, 93, 94, 95, 96, 97, 98, 99, and 100% similarity to known *Bacillus* genome sequences, where any lower limit can be paired with any mathematically compatible upper limit. In some embodiments, the microbe includes a gene cluster for the production of Macrolactin H having a similarity of at least 80%, at least 85%, at least 90%, at least 95%, or at least 99% similarity to known *Bacillus* genome sequences.

[0078] The microbe of one or more embodiments may have a gene cluster for the production of diffidin having a gene cluster similarity in a range having a lower limit of any one of 35%, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, and 55% similarity to known *Bacillus* genome sequences and an upper limit of any one of 45%, 50, 55, 60, 65, 70, 75, 80, 85, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, and 100%

similarity to known *Bacillus* genome sequences, where any lower limit can be paired with any mathematically compatible upper limit. In some embodiments, the microbe includes a gene cluster for the production of difficidin having a similarity of at least 35%, at least 40%, at least 45%, at least 50%, at least 52%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, or at least 99% similarity to known *Bacillus* genome sequences.

[0079] The microbe of one or more embodiments may have a gene cluster for the production of bacilysin having a gene cluster similarity in a range having a lower limit of any one of 35%, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, and 55% similarity to known *Bacillus* genome sequences and an upper limit of any one of 45%, 50, 55, 60, 65, 70, 75, 80, 85, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, and 100% similarity to known *Bacillus* genome sequences, where any lower limit can be paired with any mathematically compatible upper limit. In some embodiments, the microbe includes a gene cluster for the production of bacilysin having a similarity of at least 35%, at least 40%, at least 45%, at least 50%, at least 52%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, or at least 99% similarity to known *Bacillus* genome sequences.

[0080] The microbe of one or more embodiments may have a gene cluster for the production of bacillibactin having a gene cluster similarity in a range having a lower limit of any one of 35%, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, and 55% similarity to known *Bacillus* genome sequences and an upper limit of any one of 45%, 50, 55, 60, 65, 70, 75, 80, 85, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, and 100% similarity to known *Bacillus* genome sequences, where any lower limit can be paired with any mathematically compatible upper limit. In some embodiments, the microbe includes a gene cluster for the production of bacillibactin having a similarity of at least 35%, at least 40%, at least 45%, at least 50%, at least 52%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, or at least 99% similarity to known *Bacillus* genome sequences.

[0081] The microbe of one or more embodiments may have a gene cluster for the production of surfactin having a gene cluster similarity in a range having a lower limit of any one of 35%, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, and 55% similarity to known *Bacillus* genome sequences and an upper limit of any one of 45%, 50, 55, 60, 65, 70, 75, 80, 85, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, and 100% similarity to known *Bacillus* genome sequences, where any lower limit can be paired with any mathematically compatible upper limit. In some embodiments, the microbe includes a gene cluster for the production of surfactin having a similarity of at least 35%, at least 40%, at least 45%, at least 50%, at least 52%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, or at least 99% similarity to known *Bacillus* genome sequences.

[0082] The microbe of one or more embodiments may have a gene cluster for the production of bacillaene having a gene cluster similarity in a range having a lower limit of any one of 35%, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, and 55% similarity to known *Bacillus* genome sequences and an upper limit of any one of 45%, 50, 55, 60, 65, 70, 75, 80, 85, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, and 100% similarity to known *Bacillus* genome sequences, where any lower limit can be paired with any mathematically compatible upper limit. In some embodiments, the microbe includes a gene cluster for the production of bacillaene having a similarity of at least 35%, at least 40%, at least 45%, at least 50%, at least 52%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, or at least 99% similarity to known *Bacillus* genome sequences.

[0083] A microbe or a formulation including a microbe of one or more embodiments, for example, a *Bacillus amyloliquefaciens* BC17B strain, may be capable of reducing disease by protecting a plant against a fungus, bacteria, nematodes, or insects. For example, a microbe of the disclosure (*e.g.*, a *Bacillus amyloliquefaciens* BC17B strain) may reduce disease by protecting a plant against an infectious fungus. A microbe of one or more embodiments, for example, a *Bacillus amyloliquefaciens* BC17B strain, may reduce disease by broadly protecting a plant against a fungus, bacteria, nematodes, or insects. A microbe of one or more embodiments, for example, a *Bacillus amyloliquefaciens* BC17B

strain, may reduce disease and act as broad-spectrum fungicide, bactericide, nematocide, or insecticide.

[0084] A microbe or a formulation including a microbe of one or more embodiments, for example, a *Bacillus amyloliquefaciens* BC17B strain, may reduce disease by protecting a plant against one or more pathogenic organisms belonging to the genus of Phakopsora, Magnaporthe, Cochliobolus, Sphaerulina, Geotrichum, Microsphaera, Blumeria, Podosphaera, Peronospora, Pseudoperonospora, Xanthomonas, Xylella, Heterodera, Colletotrichum, or Meloidogyne. The one or more pathogenic organisms may be *Phakopsora pachyrhizi*, *Magnaporthe grisea*, *Cochliobolus miyabeanus*, *Sphaerulina oryzae*, *Geotrichum spp*, *Microsphaera diffusa*, *Blumeria graminis*, *Podosphaera leucotricha*, *Peronospora manshurica*, *Peronospora effusa*, *Peronospora belbahrii*, *Colletotrichum musae*, *Pseudoperonospora cubensis*, *Xylella fastidiosa*, *Xanthomonas campestris*, *Heterodera glycines*, *Meloidogyne hapla*, *Meloidogyne incognita*, or *Meloidogyne enterolobii*.

[0085] A microbe or a formulation including a microbe in accordance with the present disclosure, for example, a formulation including a *Bacillus amyloliquefaciens* BC17B strain, may be capable of reducing Asian soybean rust, rice blast, brown spot, narrow brown spot, sour rot (citrus, post-harvest), olive quick decline syndrome, Pierce's disease (grapes), leaf scorch (almonds, coffee), Black rot, soybean cysts, or root knots. A microbe or a formulation including a microbe of the disclosure (e.g., a *Bacillus amyloliquefaciens* BC17B strain) may reduce Asian soybean rust, rice blast, brown spot, narrow brown spot, sour rot (citrus, post-harvest), olive quick decline syndrome, Pierce's disease (grapes), leaf scorch (almonds, coffee), Black rot, soybean cysts, or root knots by at least about 5%, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, or at least about 99%, relative to a control plant having a disease and not contacted with the *Bacillus amyloliquefaciens*.

[0086] A *Bacillus amyloliquefaciens* BC17B strain or a formulation including the BC17B strain of the present disclosure, may be capable of reducing Asian soybean rust disease caused by a *Phakopsora* *e.g.*, *Phakopsora pachyrhizi*, by at least about 5%, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, or at least about 99%, relative to a control plant having a disease and not contacted with the *Bacillus amyloliquefaciens*.

[0087] A *Bacillus amyloliquefaciens* BC17B strain or a formulation including the BC17B strain of the present disclosure may be capable of reducing rice blast disease caused by a *Magnaporthe* *e.g.*, *Magnaporthe grisea*, by at least about 5%, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, or at least about 99%, relative to a control plant having a disease and not contacted with the *Bacillus amyloliquefaciens*.

[0088] A *Bacillus amyloliquefaciens* BC17B strain or a formulation including the BC17B strain of the present disclosure may be capable of reducing a brown spot disease caused by a *Cochliobolus* *e.g.*, *Cochliobolus miyabeanus*, by at least about 5%, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, or at least about 99%, relative to a control plant having a disease and not contacted with the *Bacillus amyloliquefaciens*.

[0089] A *Bacillus amyloliquefaciens* BC17B strain or a formulation including the BC17B strain of the present disclosure may be capable of reducing narrow brown spot disease caused by a *Sphaerulina* *e.g.*, *Sphaerulina oryzina*, by at least about 5%, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 91%, at least

about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, or at least about 99%, relative to a control plant having a disease and not contacted with the *Bacillus amyloliquefaciens*.

[0090] A *Bacillus amyloliquefaciens* BC17B strain or a formulation including the BC17B strain of the present disclosure may be capable of reducing a sour rot (citrus, post-harvest) disease caused by a *Geotrichum e.g., Geotrichum spp.*, by at least about 5%, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, or at least about 99%, relative to a control plant having a disease and not contacted with the *Bacillus amyloliquefaciens*.

[0091] A *Bacillus amyloliquefaciens* BC17B strain or a formulation including the BC17B strain of the present disclosure may be capable of reducing olive quick decline syndrome, Pierce's disease (grapes), citrus variegated chlorosis, or leaf scorch (almonds, coffee) caused by a *Xylella e.g., Xylella fastidiosa*, by at least about 5%, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, or at least about 99%, relative to a control plant having a disease and not contacted with the *Bacillus amyloliquefaciens*.

[0092] A *Bacillus amyloliquefaciens* BC17B strain or a formulation including the BC17B strain of the present disclosure may be capable of reducing black rot disease caused by a *Xanthomonas e.g., Xanthomonas campestris*, by at least about 5%, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, or at least about 99%, relative to a control plant having a disease and not contacted with the *Bacillus amyloliquefaciens*.

[0093] A *Bacillus amyloliquefaciens* BC17B strain or a formulation including the BC17B strain of the present disclosure may be capable of reducing soybean cyst disease caused by a *Heterodera* e.g., *Heterodera glycines*, by at least about 5%, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, or at least about 99%, relative to a control plant having a disease and not contacted with the *Bacillus amyloliquefaciens*.

[0094] A *Bacillus amyloliquefaciens* BC17B strain or a formulation including the BC17B strain of the present disclosure may be capable of reducing root knot disease caused by a *Meloidogyne*, e.g., *Meloidogyne hapla*, *Meloidogyne incognita*, or *Meloidogyne enterolobii*, by at least about 5%, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, or at least about 99%, relative to a control plant having a disease and not contacted with the *Bacillus amyloliquefaciens*.

[0095] A *Bacillus amyloliquefaciens* BC17B strain or a formulation including the BC17B strain of the present disclosure may be capable of reducing powdery mildew disease caused by a *Microsphaera*, e.g., *Microsphaera diffusa*, by at least about 5%, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, or at least about 99%, relative to a control plant having a disease and not contacted with the *Bacillus amyloliquefaciens*.

[0096] A *Bacillus amyloliquefaciens* BC17B strain or a formulation including the BC17B strain of the present disclosure may be capable of reducing powdery mildew disease caused by a *Blumeria*, e.g., *Blumeria graminis*, by at least about 5%, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%,

at least about 70%, at least about 80%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, or at least about 99%, relative to a control plant having a disease and not contacted with the formulation or the *Bacillus amyloliquefaciens*.

[0097] A *Bacillus amyloliquefaciens* BC17B strain or a formulation including the BC17B strain of the present disclosure may be capable of reducing powdery mildew disease caused by a *Podosphaera*, e.g., *Podosphaera leucotricha*, by at least about 5%, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, or at least about 99%, relative to a control plant having a disease and not contacted with the *Bacillus amyloliquefaciens*.

[0098] A *Bacillus amyloliquefaciens* BC17B strain or a formulation including the BC17B strain of the present disclosure may be capable of reducing downy mildew disease caused by a *Peronospora*, e.g., *Podosphaera leucotricha*, *Peronospora manshurica*, *Peronospora effusa*, or *Peronospora belbahrii*, by at least about 5%, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, or at least about 99%, relative to a control plant having a disease and not contacted with the *Bacillus amyloliquefaciens*.

[0099] A *Bacillus amyloliquefaciens* BC17B strain or a formulation including the BC17B strain of the present disclosure may be capable of reducing downy mildew disease caused by a *Pseudoperonospora*, e.g., *Pseudoperonospora cubensis*, by at least about 5%, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, or at least about 99%, relative to a control plant having a disease and not contacted with the *Bacillus amyloliquefaciens*.

[00100] A *Bacillus amyloliquefaciens* BC17B strain or a formulation including the BC17B strain of the present disclosure may be capable of reducing crown rot caused by a *Colletotrichum*, e.g., *Colletotrichum musae*, by at least about 5%, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98%, or at least about 99%, relative to a control plant having a disease and not contacted with the *Bacillus amyloliquefaciens*.

[00101] METHOD FOR GROWING A BIOCONTROL MICROBE

[00102] In another aspect, embodiments herein relate to growing a biocontrol microbe. The biocontrol microbe may be as described above. The microbe of one or more embodiments can be grown in a culture. The microbe can be isolated and purified from the culture. The microbe purified from the culture may include a vegetative cell, a spore of the microbe, or any combinations thereof. The culture used to grow the microbe may include a solid medium or a semi-solid medium. The culture used to grow the microbe may include a liquid medium. The culture can include a bioreactor. Any suitable bioreactor can be used to grow the microbe. Examples of bioreactors include, but are not limited to a flask, continuously stirred tank bioreactor (CSTR), a bubbleless bioreactor, an airlift reactor, and a membrane bioreactor.

[00103] In some embodiments, a supernatant of the culture can be collected. The supernatant may include one or more molecules synthesized by the microbe. The one or more molecules synthesized by the microbe can be isolated or purified from the supernatant, or otherwise enriched to generate a solution including the one or more molecules. The supernatant, the isolated one or more molecules, the purified one or more molecules, the enriched solution including one or more molecules, or any combination thereof may be added to a formulation to produce a biocontrol composition in accordance with one or more embodiments. For example, the one or more molecules may be isolated and/or purified from the supernatant and the purified and/or isolated molecules may be applied to a plant, e.g., as a fraction isolated or purified from the liquid and including the

one or more molecules. The one or more molecules may be enriched, purified, or isolated such that the concentration of the one or more molecules may be increased. The one or more molecules may be enriched, purified, or isolated such that the number of different molecules in a solution is reduced. In some cases, the supernatant can be applied as the formulation as described elsewhere herein.

[00104] The one or more molecules may include a molecule selected from the group consisting of lipopeptides, polyketides, peptides, dipeptides, polypeptides, cyclic polypeptides, polyenes, aminoglycosides, surfactants, siderophores, and combinations thereof. The lipopeptides may include one or more selected from the group consisting of fengycin, plipastatin, and surfacticin. The polyketides may include one or more selected from macrolactin H, and difficidin. The peptide compounds may include one or more selected from bacilysin, and rhizocticin A. The aminoglycoside compounds may include one or more selected from butirosin A, and butirosin B. In one or more embodiments, the surfactant compound includes surfactin. The siderophore may be a bacillibactin compound. The one or more molecules (e.g., one or more small molecules) synthesized by the microbe may have antibiotic, anti-fungal, anti-nematodal, or anti-insect properties. For example, the one or more molecules may include a molecule with previously identified antibacterial properties.

[00105] BIOCONTROL COMPOSITION

[00106] In one aspect, embodiments disclosed herein relate to a biocontrol composition (or “formulation”). The composition of one or more embodiments may include a *Bacillus amyloliquefaciens* microbe, one or more molecules synthesized by the *Bacillus amyloliquefaciens* microbe, or any combination thereof. The *Bacillus amyloliquefaciens* microbe and the one or more molecules synthesized by the *Bacillus amyloliquefaciens* may be as previously described. An additional embodiment of the present disclosure is a formulation including a *Bacillus amyloliquefaciens* spore that includes a nucleic acid comprising a sequence that is a certain percentage (for example, at least 99.8%) identical to SEQ ID NO: 1. The formulation may include viable *Bacillus amyloliquefaciens* after storage at a temperature in a particular range and a particular number of days, such as from

about 18°C to about 25°C or at a temperature of up to about 50°C for at least 14 days, the stable formulation comprises viable *Bacillus amyloliquefaciens* after storage at a temperature of up to about 50°C for 14 days.

[00107] In one or more embodiments, the microbe is present as part of a formulation. The microbe may be included in a biocontrol composition that is a stable formulation, such as a liquid formulation or a dry formulation. The liquid formulation may be a flowable or aqueous suspension. The liquid formulation may include the microbe, a secondary metabolite thereof, or both suspended in water, oil, or a combination thereof (e.g., in an emulsion). A dry formulation may include a wettable powder, a dry flake, a dust, or a granule. A wettable powder can be applied to the plant, the seed, the flower, or the produce thereof as a suspension. A dust can be applied to the plant, the seed, or the produce thereof dry, such as to seeds or foliage. A granule can be applied dry or can be mixed with an aqueous fluid (e.g., water) to create a suspension or dissolved in the aqueous fluid to make a solution. The microbe, a secondary metabolite thereof, or any combination thereof can be formulated as a microencapsulation. The microbe, a secondary metabolite thereof, or any combination thereof has a protective inert layer. The protective inert layer can comprise any suitable polymer.

[00108] In one or more embodiments, the formulation includes spores. For example, the formulation may include *Bacillus amyloliquefaciens* spores. Spore-containing compositions can be applied to treat a plant pathogen by one or more methods described herein. Spore-containing compositions according to one or more embodiments herein may extend the shelf life of the formulation.

[00109] In one or more embodiments, the formulation includes vegetative cells. The formulation may include *Bacillus amyloliquefaciens* vegetative cells. Vegetative cell-containing compositions can be applied to treat a plant pathogen by methods described herein. Vegetative cells may proliferate and increase the efficacy of the biocontrol composition in accordance with one or more embodiments. For example, vegetative cells in the formulation may be capable of proliferating after treatment application, increasing the surface area of the plant that is exposed to the formulation. In another example,

vegetative cells in the formulation may be capable of proliferating after application, thereby increasing the amount of the survival time of the formulation, and thus, extending the time the formulation has efficacy. In one or more embodiments, the vegetative cells may proliferate and compete for nutrients with a pathogen. The vegetative cells of one or more embodiments may be capable of actively producing one or more secondary metabolites with anti-pathogen properties. In some embodiments, vegetative cells in a formulation may become spores, allowing them any advantages of spores.

[00110] The formulation may include an additional compound. The additional compound may include one or more selected from the group consisting of a buffer salt, carrier, a surfactant, a wetting agent, a penetrant, an emulsifier, a spreader, a sticker, a stabilizer, a nutrient, a binder, a desiccant, a thickener, a dispersant, a UV protectant, and combinations thereof. The carrier may be a liquid carrier, a mineral carrier, or an organic carrier. The additional compound may include a surfactant that is an agricultural adjuvant. The surfactant may include an organo-modified siloxane. In some embodiments, the surfactant can include non-ionic surfactants. The surfactant may be commercially available, such as a Breakthru® surfactant available from Evonik. In some embodiments, the surfactant is included in the formulation in an amount in a range having a lower limit of any one of a non-zero amount, 0.01 wt%, 0.02 wt%, 0.05 wt%, 0.075 wt%, 0.1 wt%, 0.15 wt%, 0.18 wt%, and 0.2 wt% and an upper limit of any one of 0.2 wt%, 0.22 wt%, 0.25 wt%, 0.27 wt%, 0.3 wt%, 0.5 wt%, 1 wt%, 5 wt%, 10 wt%, 15 wt%, 20 wt%, and 25 wt%, where any lower limit can be paired with any mathematically compatible upper limit. The formulation may be formulated as or included in a solution. For example, the formulation may be dissolved in water. In one or more embodiments, the composition may include an aqueous solution including one or more of at least one buffer salt, a *Bacillus amyloliquefaciens* microbe, and one or more molecules synthesized by the *Bacillus amyloliquefaciens* microbe.

[00111] In some embodiments, the formulation may be buffered to maintain a pH or osmolarity. The formulation may have a pH or osmolarity suitable for uptake *via* a plant. The formulation may comprise a pH or osmolarity suitable for uptake *via* a plant without changing the pH or osmolarity of cells in the plant. For example, the formulation may be

at a pH of at least 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 or more. For example, the formulation may be at a pH of no more than 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 or less. In some embodiments, the formulation has a pH in a range having a lower limit of any one of 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12 and an upper limit of any one of 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14, where any lower limit can be paired with any mathematically compatible upper limit. For example, the formulation may be at a pH from about 3 to about 8. The formulation may be at a pH from about 5 to about 8. The formulation may be at a pH from about 3 to about 8. The formulation may be at a pH from about 6 to about 9. The formulation may be at a pH from about 3 to about 8. The formulation may be at a pH from about 6 to about 11. For example, the formulation may be at a pH from about 6 to about 8. In one or more particular embodiments, for example, the formulation may be at a biological pH of about 7.4, such as in a range from a pH of about 7 to about 7.5.

[00112] The formulation may be a stable formulation having an osmotic concentration in a range from 0.05 mM to 1.5 M solute. For example, the formulation may have an osmotic concentration in a range having a lower limit of any one of 0.05 mM, 0.075 mM, 0.8 mM, 0.9 mM, 0.1 mM, 0.25 mM, 0.5 mM, 0.75 mM, 1.0 mM, 5.0 mM, 10 mM, 25 mM, 50 mM, 75 mM, 100 mM, 250 mM, and 500 mM, and an upper limit of any one of 1.0 mM, 2.5 mM, 5.0 mM, 10 mM, 25 mM, 50 mM, 75 mM, 100 mM, 250 mM, 500 mM, 1M, and 1.5 M solute, where any lower limit can be paired with any mathematically compatible upper limit.

[00113] The formulation may be stable such that the formulation is capable of maintaining efficacy or viability after storage. The formulation may be stable after a period of time having a range from 1 day to 12 years or more. In some embodiments, the formulation is stable after a period of time having a range with a lower limit of any one of 1 day, 2 days, 3 days, 4 days, 5 days, 6 days, 7 days, 8 days, 9 days, 10 days, 11 days, 12, days, 13 days, 14 days, 15 days, 16 days, 17 days, 18 days, 19 days, 20 days, 21 days, 22, days, 23 days, 24 days, 25 days, 26 days, 27 days, 28 days, 29 days, 30 days, 1 month, 2 months, 3 months, 4 months, 5 months, 6 months, 7 months, 8 months, 9 months, 10 months, 11 months, and 12 months or more and an upper limit of any one of 1 month, 2 months, 3 months, 4 months, 5 months, 6 months, 7 months, 8 months, 9 months, 10 months, 11 months, 12 months, 2

years, 3 years, 4 years, 5 years, 6 years, 7 years, 8 years, 9 years, 10 years, 11 years, 12, years, or more, where any lower limit can be paired with any mathematically compatible upper limit.

[00114] As a non-limiting example, the formulation may be stable after storage after 1 day. For example, the formulation may be stable after storage after 1 day, 2 days, 3 days, 4 days, 5 days, 6 days, 7 days, 8 days, 9 days, 10 days, 11 days, 12, days, 13 days, 14 days, 15 days, 16 days, 17 days, 18 days, 19 days, 20 days, 21 days, 22, days, 23 days, 24 days, 25 days, 26 days, 27 days, 28 days, 29 days, 30 days, or more. For example, the formulation may be stable after storage after 1 month, 2 months, 3 months, 4 months, 5 months, 6 months, 7 months, 8 months, 9 months, 10 months, 11 months, 12, months, or more. For example, the formulation may be stable after storage after 1 year, 2 years, 3 years, 4 years, 5 years, 6 years, 7 years, 8 years, 9 years, 10 years, 11 years, 12, years, or more.

[00115] The formulation may be stable after storage for the period of time as described above and under a storage temperature. The storage temperature may be a temperature in a range having a lower limit of any one of at least 4°C, 5°C, 6°C, 7°C, 8°C, 9°C, 10°C, 11°C, 12°C, 13°C, 14°C, 15°C, 16°C, 17°C, 18°C, 19°C, 20°C, 21°C, 22°C, 23°C, 24°C, 25°C, 26°C, 27°C, 28°C, 29°C, 30°C, 31°C, 32°C, 33°C, 34°C, 35°C, 36°C, 37°C, 38°C, 39°C, 40°C, 41°C, 42°C, 43°C, 44°C, 45°C, 46°C, 47°C, 48°C, 49°C, 50°C, 51°C, 52°C, 53°C, 54°C, 55°C, 56°C, 57°C, 58°C, 59°C, and 60°C with an upper limit of any one of 25°C, 26°C, 27°C, 28°C, 29°C, 30°C, 31°C, 32°C, 33°C, 34°C, 35°C, 36°C, 37°C, 38°C, 39°C, 40°C, 41°C, 42°C, 43°C, 44°C, 45°C, 46°C, 47°C, 48°C, 49°C, 50°C, 51°C, 52°C, 53°C, 54°C, 55°C, 56°C, 57°C, 58°C, 59°C, and 60°C, 61°C, 62°C, 63°C, 64°C, 65°C, 66°C, 67°C, 68°C, 69°C, and 70°C or more, where any lower limit can be paired with any mathematically compatible upper limit.

[00116] For example, the formulation may be stable after storage at a temperature of at least 4°C, 5°C, 6°C, 7°C, 8°C, 9°C, 10°C, 11°C, 12°C, 13°C, 14°C, 15°C, 16°C, 17°C, 18°C, 19°C, 20°C, 21°C, 22°C, 23°C, 24°C, 25°C, 26°C, 27°C, 28°C, 29°C, 30°C, 31°C, 32°C, 33°C, 34°C, 35°C, 36°C, 37°C, 38°C, 39°C, 40°C, 41°C, 42°C, 43°C, 44°C, 45°C, 46°C, 47°C, 48°C, 49°C, 50°C, 51°C, 52°C, 53°C, 54°C, 55°C, 56°C, 57°C, 58°C, 59°C, 60°C ,

61°C, 62°C, 63°C, 64°C, 65°C, 66°C, 67°C, 68°C, 69°C, 70°C, or more. For example, the formulation may be stable after storage of at least 1 day, 2, days, 3 days, 4 days, 5 days, 6 days, 7 days, 8 days, 9 days, 10 days, 11 days, 12, days, 13 days, 14 days, 15 days, 16 days, 17 days, 18 days, 19 days, 20 days, or more, at a storage temperature as described above. In one or more embodiments, the formulation is stable after storage of at least 1 day, 2, days, 3 days, 4 days, 5 days, 6 days, 7 days, 8 days, 9 days, 10 days, 11 days, 12, days, 13 days, 14 days, 15 days, 16 days, 17 days, 18 days, 19 days, 20 days, or more, at a temperature of at least 4°C, 5°C, 6°C, 7°C, 8°C, 9°C, 10°C, 11°C, 12°C, 13°C, 14°C, 15°C, 16°C, 17°C, 18°C, 19°C, 20°C, 21°C, 22°C, 23°C, 24°C, 25°C, 26°C, 27°C, 28°C, 29°C, 30°C, 31°C, 32°C, 33°C, 34°C, 35°C, 36°C, 37°C, 38°C, 39°C, 40°C, 41°C, 42°C, 43°C, 44°C, 45°C, 46°C, 47°C, 48°C, 49°C, 50°C, 51°C, 52°C, 53°C, 54°C, 55°C, 56°C, 57°C, 58°C, 59°C, 60°C, 61°C, 62°C, 63°C, 64°C, 65°C, 66°C, 67°C, 68°C, 69°C, 70°C, or more.

[00117] For example, the formulation may be stable after storage after 1 month, 2 months, 3 months, 4 months, 5 months, 6 months, 7 months, 8 months, 9 months, 10 months, 11 months, 12, months, or more, at least 4°C, 5°C, 6°C, 7°C, 8°C, 9°C, 10°C, 11°C, 12°C, 13°C, 14°C, 15°C, 16°C, 17°C, 18°C, 19°C, 20°C, 21°C, 22°C, 23°C, 24°C, 25°C, 26°C, 27°C, 28°C, 29°C, 30°C, 31°C, 32°C, 33°C, 34°C, 35°C, 36°C, 37°C, 38°C, 39°C, 40°C, 41°C, 42°C, 43°C, 44°C, 45°C, 46°C, 47°C, 48°C, 49°C, 50°C, 51°C, 52°C, 53°C, 54°C, 55°C, 56°C, 57°C, 58°C, 59°C, 60°C, 61°C, 62°C, 63°C, 64°C, 65°C, 66°C, 67°C, 68°C, 69°C, 70°C, or more. For example, the formulation may be stable after storage after 1 year, 2 years, 3 years, 4 years, 5 years, 6 years, 7 years, 8 years, 9 years, 10 years, 11 years, 12, years, or more, at least 4°C, 5°C, 6°C, 7°C, 8°C, 9°C, 10°C, 11°C, 12°C, 13°C, 14°C, 15°C, 16°C, 17°C, 18°C, 19°C, 20°C, 21°C, 22°C, 23°C, 24°C, 25°C, 26°C, 27°C, 28°C, 29°C, 30°C, 31°C, 32°C, 33°C, 34°C, 35°C, 36°C, 37°C, 38°C, 39°C, 40°C, 41°C, 42°C, 43°C, 44°C, 45°C, 46°C, 47°C, 48°C, 49°C, 50°C, 51°C, 52°C, 53°C, 54°C, 55°C, 56°C, 57°C, 58°C, 59°C, 60°C, 61°C, 62°C, 63°C, 64°C, 65°C, 66°C, 67°C, 68°C, 69°C, 70°C, or more.

[00118] The formulation after storage, such as at any of the storage conditions described in one or more embodiments of this disclosure, may include viable *Bacillus amyloliquefaciens*. The formulation after storage may comprise a reduction of number of

viable *Bacillus amyloliquefaciens* of no more than 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, or less. In some embodiments, the formulation after storage include a reduction of number of viable *Bacillus amyloliquefaciens* in a range from 0% to 90%. In one or more embodiments, the formulation after storage may include a reduction of number of viable *Bacillus amyloliquefaciens* in a range having a lower limit of any one of 0%, 2.5%, 5%, 7.5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 60% and 70% and an upper limit of any one of 10%, 15%, 20%, 25%, 30%, 35%, 40%, 50%, 60%, 70%, 75%, 80%, 85%, and 90%, where any lower limit can be paired with any mathematically compatible upper limit.

[00119] The reduction of viability may be determined *via* comparison or metric of viability, for example, colony forming units per volume, or optical density of a solution. For example, reduction of viability may comprise comparing the CFU/ml of a freshly made formulation versus the CFU/ml of a formulation that was stored for a longer period of time.

[00120] The storage of the formulation, such as at any of the storage conditions described in this disclosure, may maintain at least a portion of the efficacy of the formulation prior to storage. For example, the formulation after storage may comprise a reduction of efficacy against a fungus, bacteria, nematode, or insect of no more than 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, or less. In some embodiments, the formulation after storage may include a reduction of efficacy against a fungus, bacteria, nematode, or insect of in a range from 0% to 90%. In one or more embodiments, the formulation after storage includes a reduction of efficacy against a fungus, bacteria, nematode, or insect of in a range having a lower limit of any one of 0%, 2.5%, 5%, 7.5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 60% and 70% and an upper limit of any one of 10%, 15%, 20%, 25%, 30%, 35%, 40%, 50%, 60%, 70%, 75%, 80%, 85%, and 90%, where any lower limit can be paired with any mathematically compatible upper limit.

[00121] The reduction of efficacy may be determined *via* comparison or calculation of disease severity index, disease severity, average disease severity, percent average disease severity, disease index, average disease index, percent disease index, or other metric of agricultural disease. For example, reduction of efficacy determination may include

comparing the reduction of disease severity of a plant that was applied a freshly made formulation versus the reduction of disease severity of a plant that was applied a formulation that was stored for a longer period of time.

[00122] In one or more embodiments, the formulation can be formulated such that the microbes can replicate once they are applied or delivered to the target habitat. For example, the formulation may be capable of replicating once applied to one or more of soil proximate to the plant, the plant, a seed, and a plant product (i.e., produce) growing from or harvested from the plant.

[00123] The formulation may have anti-pathogen activity, such as prevention of growth of a pathogen or reduction of growth of a pathogen on a plant, a seed, or a produce thereof. The formulation may be capable of preventing growth of a pathogen on the plant, seed, or produce thereof for at least 1, at least 2, at least 3, at least 4, or at least 5 days, or longer. The formulation may be capable of preventing growth of a pathogen on the plant, seed, or produce thereof for at least 1, at least 2, at least 3, at least 4, at least 5 days, at least 6 days, at least 7 days, at least 8 days, at least 9 days, or at least 10 days or longer. The formulation may be capable of preventing growth of a pathogen on the plant, seed, or produce thereof for over 10 days.

[00124] The formulation may be capable of reducing growth of the pathogen on the plant, seed, or produce thereof relative to growth of the pathogen on a control that is a plant, a seed, flower, or a produce thereof not exposed to the formulation. The control can be a plant, a seed, or a produce thereof to which no anti-pathogen agent has been applied or can be a plant, a seed, flower, or produce thereof to which a commercially available anti-pathogen agent has been applied. The commercially available control may include a Serenade® product (e.g., Serenade® Aso and/or Serenade® Opti) obtainable from Bayer Crop Sciences (US), which includes an active ingredient of a QST713 strain of *Bacillus subtilis*.

[00125] In some embodiments, the formulation can reduce growth of a pathogen on the plant, seed, or produce thereof for at least 1, at least 2, at least 3, at least 4, or at least 5 days. The formulation may be capable of reducing growth of a pathogen on the plant, seed,

or produce thereof for at least 1, at least 2, at least 3, at least 4, at least 5 days, at least 6 days, at least 7 days, at least 8 days, at least 9 days, or at least 10 days. The formulation may be capable of reducing growth of a pathogen on the plant, seed, or produce thereof for over 10 days. The formulation may be capable of reducing growth of the pathogen of at least 25% relative to growth of the pathogen on a control. The formulation may be capable of reducing growth of the pathogen of at least 60% relative to growth of the pathogen on the control. The formulation may be capable of reducing growth of the pathogen of at least 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60 %, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 99%, or more relative to growth of the pathogen on the control.

[00126] METHOD FOR USING A BIOCONTROL COMPOSITION

[00127] In another aspect, embodiments disclosed herein relate to methods for using a biocontrol composition. The biocontrol composition may be as described previously. For example, the biocontrol composition may be *Bacillus amyloliquefaciens* microbe including a nucleic acid a sequence that is at least 99.8% identical to SEQ ID NO: 1, and/or one or more molecules synthesized by said *Bacillus amyloliquefaciens*. In some embodiments, the biocontrol composition includes a formulation containing *Bacillus amyloliquefaciens* includes a nucleic acid including a sequence that is at least 99.8% identical to SEQ ID NO: 1, and/or one or more molecules synthesized by said *Bacillus amyloliquefaciens*. In some embodiments, *Bacillus amyloliquefaciens* includes a nucleic acid including a sequence that is at least 99.8% identical to SEQ ID NO: 1, and/or one or more molecules synthesized by said *Bacillus amyloliquefaciens* may be provided in a stable formulation as described herein. The methods for using the biocontrol composition may include a method of treating a plant, seed, soil including the plant, or any combination thereof with a biocontrol composition of one or more embodiments. In one or more embodiments, a method for using a biocontrol composition is directed to a method of plant and/or produce treatment.

[00128] An additional aspect of the present disclosure is a method for treating a disease in a plant, a seed, or soil comprising a plant. The method of one or more embodiments may include obtaining a plant, a seed, and/or soil that includes a plant having a disease. The

method may include contacting the plant, the seed, or soil comprising the plant, (i) with a *Bacillus amyloliquefaciens* that includes a nucleic acid comprising a sequence that is a certain percentage (e.g., at least 99.8%) identical to SEQ ID NO: 1, and/or (ii) with one or more molecules synthesized by said *Bacillus amyloliquefaciens*. The *Bacillus amyloliquefaciens* may be formulated in a biocontrol composition in accordance with one or more embodiments. In this aspect, the contacting reduces growth of or kills, one or more pathogenic organisms present on or inside the plant, the seed, and/or the soil including the plant, where the pathogenic organism is responsible for the disease.

[00129] Another aspect of the present disclosure is a method for preventing or reducing severity of a disease in a plant, a seed, or soil comprising a plant. The method comprises steps of: obtaining a plant, a seed, or soil comprising a plant at risk for contracting a disease and contacting the plant, the seed, or soil comprising the plant, (i) with a *Bacillus amyloliquefaciens* comprising a nucleic acid comprising a sequence that is a certain percentage (e.g., at least 99.8%) identical to SEQ ID NO: 1, and/or (ii) with one or more molecules synthesized by said *Bacillus amyloliquefaciens*. The *Bacillus amyloliquefaciens* may be formulated in a biocontrol composition in accordance with one or more embodiments. In this aspect, the contacting reduces growth of or kills, one or more pathogenic organisms present on or inside the plant, the seed, and/or the soil comprising the plant, where the pathogenic organism is responsible for the disease.

[00130] The method of plant treatment may be used to treat one or more plant pathogens and/or one or more plant diseases. The one or more plant pathogens may include at least one plant pathogen described herein. The disease may include, but is not limited to, Asian soybean rust, rice blast, brown spot, narrow brown spot, crown rot, sour rot (citrus, post-harvest), olive quick decline syndrome, Pierce's disease (grapes), leaf scorch (almonds, coffee), citrus variegated chlorosis, Black rot, soybean cysts, or root knots. In this aspect, the contacting reduces growth of or kills, one or more pathogenic organisms present on or inside the plant, the seed, and/or the soil including the plant, where the pathogenic organism is responsible for the disease. In some embodiments, one or more molecules are secreted by the *Bacillus amyloliquefaciens* into a liquid including the *Bacillus amyloliquefaciens* such that the contacting includes contacting the liquid with one or more of the plant, the

seed, or the soil including the plant and/or contacting a fraction isolated or purified from the liquid and the one or more molecules with one or more of the plant, the seed, or the soil including the plant. In some embodiments, the one or more molecules secreted from *Bacillus amyloliquefaciens* is purified prior to the contacting step.

[00131] One or more methods of the present disclosure is a method that includes contacting one or more of a plant, a seed, or a soil including a plant with a biocontrol composition (e.g., a biocontrol microbe and/or a formulation in accordance with one or more embodiments). The step of contacting may include dusting, dipping, rolling, injecting, rubbing, spraying, and/or brushing one or more of a plant, seed, or soil including the plant. In some embodiments, the contacting includes contacting a leaf, root, fruit, seed, flower, or stem of the plant with the biocontrol microbe and/or biocontrol composition. In one or more embodiments, the contacting reduces growth of or kills, one or more pathogenic organisms present on or inside the plant, the seed, the soil comprising the plant, or any combination thereof. As a non-limiting example, the contacting may kill, reduce growth, reduce reproduction, or any combination thereof of an infectious fungus or a disease-causing endophyte. The contacting may prevent a disease or reduces the incidence and/or severity of a disease of the plant. The contacting may prevent a disease or reduces the incidence and/or severity of a disease of the plant.

[00132] In some embodiments, one or more molecules synthesized by said *Bacillus amyloliquefaciens* kills, damages, slows the growth of, reduces the reproduction of the fungus, bacterium, or nematode, or any combination thereof by any of the following modes of action: damage to the cell membrane; disintegration of the cell membrane or osmotic pressure imbalance; changes to cell membrane permeability; formation of pores in the cell membrane; formation of conglomeration structures; reducing concentrations or availability of polysaccharide or other components of biofilm formation, or by downregulation for genes required for formation of such compounds; induction of plant immune responses; downregulation of genes required for cell wall synthesis, protein production, or DNA replication; inhibition of glucosamine synthase; inhibition of protein synthesis; iron chelation, or chelation of other key chemicals that prevents access by the pathogen; inhibition of biofilm formation or swarming motility.

[00133] For example, the lipopeptides may damage the cell membrane; disintegrate the cell membrane or create osmotic pressure imbalance, change cell membrane permeability, form pores in the cell membrane; form conglomeration structures, reduce concentrations or availability of polysaccharide or other components of biofilm formation or downregulate genes required for formation of such compounds, and/or induce plant immune responses. When lipopeptides include fengycin, plipastatin, surfacticin, or related compounds, the fengycin may damage the cell membrane; the plipastatin may change cell membrane permeability, forms pores in the cell membrane, and/or forms conglomeration structures; and the surfacticin may disintegrate the cell membrane or create osmotic pressure imbalance, reduce concentrations or availability of polysaccharide or other components of biofilm formation or downregulates genes required for formation of such compounds, and/or induces plant immune responses. The related compound of a compound herein may include a raw material, a precursor or a metabolite of such compound. In some embodiments, the related compound of a compound includes a catalyst, an enzyme, a co-enzyme or other component of an enzyme that is incorporated in a chemical reaction for generating such compound or a precursor thereof.

[00134] In some embodiments, the polyketides (e.g., macrolactin H, difficidin or related compounds) downregulate genes required for cell wall synthesis, protein production, or DNA replication or inhibit biofilm formation or swarming motility. Difficidin or related compounds may downregulate genes required for cell wall synthesis, protein production, or DNA replication or inhibits biofilm formation or swarming motility. In some embodiments, the peptides (e.g., bacilysin, rhizoctin A, or related compounds) inhibit glucosamine synthase. In some embodiments, the aminoglycosides (e.g., butirosin A, or butirosin B or related compounds) inhibit protein synthesis. In some embodiments, the siderophores (e.g., bacillibactin or a related compound) modify iron chelation, or chelation of other key chemicals which prevents access by the pathogen.

[00135] The one or more pathogenic organisms may be selected from the group consisting of a fungus, a bacterium, and a nematode. In some embodiments, the contact with the biocontrol composition reduces growth of or kills, one or more pathogenic organisms present on or inside the plant, the seed, or the soil comprising the plant. The pathogenic

organism may be selected from the group consisting of a fungus, a bacterium, and a nematode. The pathogenic organism may be as described herein. The one or more pathogenic organisms may infect the leaves, fruits, flowers, stems, seeds, or roots of the plant. The one or more pathogenic organisms may cause an infection inside the plant. The one or more pathogenic organisms causes an infection inside the plant via the xylem, the phloem, or an internal or external structural element. The structural element may include a stem, trunk, corm, pseudostem, or bulb. In some embodiments, the one or more pathogenic organisms causes an infection to the plant by entering the roots of the plant or leaf stomata of the plant. The one or more pathogenic organisms may include an infectious fungus or a disease-causing endophyte.

[00136] In some embodiments, the method includes preparing and/or forming the biocontrol composition. The preparing and/or forming the biocontrol composition may include one or more of growing, synthesizing, or culturing one or more components of the biocontrol composition. The preparing and/or forming the biocontrol composition may include adding a *Bacillus amyloliquefaciens* microbe and/or one or more molecules synthesized by said *Bacillus amyloliquefaciens* microbe to an aqueous solution. The method may include adding an amount of the *Bacillus amyloliquefaciens* microbe and/or one or more molecules synthesized by the *Bacillus amyloliquefaciens* microbe to an aqueous solution in an amount in a range from 1×10^2 CFU/mL (colony forming units per milliliter) to 1×10^{20} CFU/mL or more. For example, the *Bacillus amyloliquefaciens* microbe may be added to an aqueous solution in an amount in a range from 1×10^2 CFU/mL, 2.5×10^2 CFU/mL, 5×10^2 CFU/mL, 1×10^3 CFU/mL, 2.5×10^3 CFU/mL, 5×10^3 CFU/mL, 1×10^4 CFU/mL, 2.5×10^4 CFU/mL, 5×10^4 CFU/mL, 1×10^5 CFU/mL, 2.5×10^5 CFU/mL, 5×10^5 CFU/mL, 1×10^6 CFU/mL, 2.5×10^6 CFU/mL, 5×10^6 CFU/mL, 1×10^7 CFU/mL, 2.5×10^7 CFU/mL, 5×10^7 CFU/mL, 1×10^8 CFU/mL, 2.5×10^8 CFU/mL, 5×10^8 CFU/mL, 1×10^9 CFU/mL, 2.5×10^9 CFU/mL, 5×10^9 CFU/mL, 7.5×10^9 CFU/mL, 9×10^9 CFU/mL, 9.5×10^{10} CFU/mL, and 1×10^{10} CFU/mL and an upper limit of any one of 1×10^{10} CFU/mL, 2.5×10^{10} CFU/mL, 5×10^{10} CFU/mL, 1×10^{11} CFU/mL, 2.5×10^{11} CFU/mL, 5×10^{11} CFU/mL, 1×10^{12} CFU/mL, 2.5×10^{12} CFU/mL, 5×10^{12} CFU/mL, 1×10^{13} CFU/mL, 2.5×10^{13} CFU/mL, 5×10^{13} CFU/mL, 1×10^{14} CFU/mL, 2.5×10^{14} CFU/mL, 5×10^{14} CFU/mL, 1×10^{15} CFU/mL, 2.5×10^{15} CFU/mL, 5×10^{15}

CFU/mL, 1×10^{16} CFU/mL, 2.5×10^{16} CFU/mL, 5×10^{16} CFU/mL, 1×10^{17} CFU/mL, 2.5×10^{17} CFU/mL, 5×10^{17} CFU/mL, 1×10^{18} CFU/mL, 2.5×10^{18} CFU/mL, 5×10^{18} CFU/mL, 1×10^{19} CFU/mL, 2.5×10^{19} CFU/mL, 5×10^{19} CFU/mL, and 1×10^{20} CFU/mL or more, where any lower limit can be paired with any mathematically compatible upper limit. For example, the amount of (i) the *Bacillus amyloliquefaciens*, and/or (ii) the one or more molecules synthesized by the *Bacillus amyloliquefaciens* in the formulation is 1×10^2 CFU/mL or greater, 1×10^5 CFU/mL or greater, or 1×10^{10} CFU/mL or greater.

[00137] The method may include adding one or more selected from the group consisting of sodium chloride, dibasic potassium phosphate, monobasic potassium phosphate, and combinations thereof to the aqueous solution. In some embodiments, the method includes adding at least one buffer salt to the aqueous solution in a non-zero amount to about 25 wt% (weight percent). For example, at least one buffer salt may be added to the aqueous solution in a range from a non-zero amount, 0.05 wt%, 0.1 wt%, 1 wt%, 5 wt%, 7.5 wt%, 10 wt%, 12.5 wt%, and 15 wt% and an upper limit of any one of 12.5 wt%, 15 wt%, 17.5 wt%, 20 wt%, and 25 wt%, where any lower limit can be paired with any mathematically compatible upper limit. The method may include adjusting the pH of the solution to a value in a range having a lower limit of any one of 3, 4, 5, 6, 6.25, 6.5, 6.75, 7.0, 7.2, and 7.4 and an upper limit of any one of 7.4, 7.5, 7.7, 7.9, 8, 8.5, 9, 9.5, 10, 10.5, and 11, where any lower limit can be paired with any mathematically compatible upper limit.

[00138] Any herein-disclosed aspect or embodiment may include harvesting a crop from the plant, and contacting the harvested crop with the *Bacillus amyloliquefaciens* comprising a nucleic acid comprising a sequence that is a certain percentage (e.g., at least 99.8%) identical to SEQ ID NO: 1. In some cases, the harvested crop is a fruit, nut, leaf, vegetable, and/or root.

[00139] The method of one or more embodiments may include obtaining one or more of a plant, a seed, or soil including the plant having a disease, obtaining a plant, a seed, or soil including the plant at risk for contracting a disease, or combinations thereof. The plant treatment may include inoculation of any one of a plant, seed, or soil comprising the plant with a composition including a *Bacillus amyloliquefaciens* microbe such that the

composition contacts one or more portions of the plant, seed, soil including the plant, or any combination thereof. For example, a method of plant treatment may include contacting a leaf, root, or stem of the plant with the *Bacillus amyloliquefaciens* or a formulation including the *Bacillus amyloliquefaciens* microbe. In some embodiments, the *Bacillus amyloliquefaciens* includes a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1.

[00140] In some embodiments, inoculating one or more of the plant, seed, or soil including the plant reduces growth of a *Fusarium* fungus, a *Mycosphaerella* fungus, or both on the plant. In some embodiments, the inoculation reduces the of Panama disease, leaf spot disease, or both on the plant. In some embodiments, the Panama disease includes a pseudostem disease. The method of one or more embodiments may reduce pseudostem disease reduced by at least 1%, at least 5%, at least 7%, at least 10%, at least 25%, or at least 50%. In some embodiments, the method reduces pseudostem disease is reduced by an amount in a range from 15% to at least 85%, relative to a control plant having pseudostem disease and not contacted with the *Bacillus amyloliquefaciens*. For example, the method reduces pseudostem disease in a range having a lower limit of any one of 15%, 20%, 25%, and 30%, and an upper limit of any one of about 70%, 75% 80%, and 85% or more, relative to a control plant having pseudostem disease and not contacted with the *Bacillus amyloliquefaciens*.

[00141] The *Fusarium* fungus treated by a method of one or more embodiments may include *Fusarium oxysporum*. In some embodiments, the *Mycosphaerella* fungus comprises *Mycosphaerella fijiensis* or *Mycosphaerella musicola*. The plant may be a fruit plant, such as a banana tree. The leaf spot disease may include Black sigatoka. As one of ordinary skill may appreciate, disruption of photosynthesis can reduce fruit yield by up to 50%. Infection with black Sigatoka can interrupt ripening, causing fruit to ripen prematurely and unevenly, and as a result become unsuitable for export. Thus, a treatment that reduces black sigatoka may be beneficial in plants.

[00142] In some embodiments, a method of plant treatment includes inoculating a plant, seed, or soil comprising the plant with a *Bacillus amyloliquefaciens* to treat a *Xanthomonas*

pathogen. The inoculation includes contacting the microbe with one or more of the plant seed, or soil including the plant with *Bacillus amyloliquefaciens*. In one or more embodiments, the contact reduces growth of the *Xanthomonas* pathogen including, but not limited to, *Xanthomonas campestris* on the plant. In some embodiments, the contact reduces blackspot development on the plant. In some embodiments, the blackspot development is reduced by about 50-85%, relative to a control plant having blackspot and not contacted with the *Bacillus amyloliquefaciens*. In some embodiments, the blackspot development is reduced by at least 10%.

[00143] In one or more embodiments, a treatment method may include contacting a nematode with a *Bacillus amyloliquefaciens* or a formulation including the *Bacillus amyloliquefaciens*. The step of contacting the nematode may include inoculating a plant that includes the nematode with the *Bacillus amyloliquefaciens* or a formulation including the *Bacillus amyloliquefaciens*. The method or the step of contacting the nematode may include inhibiting a nematode-mediated plant disease. In some embodiments, the contacting can kill the nematode, reduce growth of the nematode, inhibits or reduces the reproduction of the nematode, or any combination thereof. In some embodiments, the nematode comprises a root-knot nematode or a soybean cyst nematode.

[00144] A treatment method of one or more embodiments may be directed to a method of treatment to reduce the growth of a *Xylella* bacterium (e.g., *Xylella fastidiosa*), *Phakopsora pachyrhizi*, or reduce the development of soybean rust on the plant on a plant. The method may include contacting a plant, seed, or soil that includes the plant with a *Bacillus amyloliquefaciens* or a formulation including the *Bacillus amyloliquefaciens*. The contacting may include, for example, inoculation. In some embodiments, the contact reduces growth of a *Xylella* bacterium on the plant, reduces development of vascular disease in the plant (e.g., leaf scorching), or both. In one or more particular embodiments, the plant includes a nut tree, such as an almond tree. In one or more particular embodiments, the plant includes a fruit plant, such as an olive tree, a berry plant (e.g., a blueberry plant), a grape vine, or any combination thereof. In some embodiments, the contacting step includes contacting a leaf, root, or stem of the plant with the *Bacillus*

amyloliquefaciens or a formulation including the *Bacillus amyloliquefaciens*. For example, the contacting may include spraying.

[00145] In one or more embodiments, a treatment method is directed to reducing the development of a rice disease, such as in a rice plant. The method may include contacting, such as inoculating, a plant, seed, a soil including the plant, or any combination thereof with a *Bacillus amyloliquefaciens* or a formulation including the *Bacillus amyloliquefaciens*. In some embodiments, the contact includes contacting a leaf, root, or stem of the plant with the *Bacillus amyloliquefaciens* or a formulation including the *Bacillus amyloliquefaciens*. The rice disease may include rice blast, narrow brown spot, brown spot, or sheath blight. In some embodiments, the rice disease in the plant is reduced by at least 10%, relative to the rice disease in a plant without the contact.

[00146] In some embodiments, a treatment method is directed to a method of post-harvest protection. The method for post-harvest production may include a contacting step (e.g., an inoculation step) of a harvested crop with a biocontrol composition in accordance with one or more embodiments. In some embodiments, the contact prevents a disease, reduces the incidence and/or severity of a disease, or combinations thereof. The harvested from may include a fruit, including, but not limited to a citrus fruit (e.g., an orange). In some embodiments, the is infected or under threat of infection from a plant pathogen, such as at least one of *Fusarium spp.*, *Botrytis spp.*, *Penicillium spp.*, *Geotrichum spp.* and *Rhizoctonia spp.* In one or more particular embodiments, the orange is infected or under threat of infection from *Penicillium digitatum*. In some embodiments, infection is prevented or disease severity is reduced.

[00147] Disclosed herein are methods of treatment for reducing growth or killing one or more pathogenic organisms present on or in a plant. The method may include contacting a plant, seed or produce thereof, or soil comprising the plant with a microbe, such as a *Bacillus amyloliquefaciens*. The *Bacillus amyloliquefaciens* may include a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1. The contact may kill, prevent growth, or reduce growth of a pathogen such as a fungus, bacterium,

nematode, or insect on or in the plant, seed or produce thereof, or soil. The contact may prevent, reverse, or reduce development of a disease related to the pathogen on the plant.

[00148] Applying the microbe or formulation to the plant can comprise dusting, dipping, rolling, injecting, rubbing, spraying, or brushing the plant with the microbe or formulation. The biocontrol composition can be applied to the produce immediately prior to harvest or immediately after harvesting or within 1 day, 2 days, 3 days, 4 days, 5 days, 6 days, or 1 week of harvesting. In some cases, the biocontrol composition is applied by the entity doing the harvesting, in a process treating the produce immediately prior to harvest or post-harvest, by the entity packaging the produce, by the entity transporting the produce, or by the entity commercially displaying the produce for sale, or a consumer.

[00149] The formulation can reduce growth of the pathogen on the plant, seed, or produce thereof relative to growth of the pathogen on a control that is a plant, a seed, flower, or a produce thereof not exposed to the formulation. The control can be a plant, a seed, or a produce thereof to which no anti-pathogen agent has been applied or can be a plant, a seed, flower, or produce thereof to which a commercially available anti-pathogen agent has been applied. The commercially available control may include a Serenade® product (such as Serenade® Opti and/or Serenade® Aso obtainable from Bayer Crop Science US), which includes an active ingredient of a QST 713 strain of *Bacillus subtilis*. The formulation can reduce growth of a pathogen on the plant, seed, or produce thereof for at least 1, at least 2, at least 3, at least 4, or at least 5 days. The formulation can reduce growth of a pathogen on the plant, seed, or produce thereof for at least 1, at least 2, at least 3, at least 4, at least 5 days, at least 6 days, at least 7 days, at least 8 days, at least 9 days, or at least 10 days. The formulation can reduce growth of a pathogen on the plant, seed, or produce thereof for over 10 days. The formulation can reduce growth of the pathogen of at least 25% relative to growth of the pathogen on the control. The formulation can reduce growth of the pathogen of at least 60% relative to growth of the pathogen on the control. The formulation can reduce growth of the pathogen of at least 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60 %, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 99%, or more relative to growth of the pathogen on the control.

[00150] The plant may include a flower, seed, and/or produce thereof. The plant, flower, seed, or produce thereof may include an almond, apricot, apple, artichoke, banana, barley, beet, blackberry, blueberry, broccoli, Brussels sprout, cabbage, cannabis, capsicum, carrot, celery, chard, cherry, citrus, corn, cucurbit, cucumber, date, fig, garlic, grape, herb, spice, kale, lettuce, mandarin, oil palm, olive, onion, orange, pea, pear, peach, peanut, papaya, parsnip, pecan, persimmon, plum, pomegranate, potato, quince, radish, raspberry, rose, rice, sloe, sorghum, soybean, spinach, strawberry, sweet potato, tobacco, tomato, turnip greens, walnut, or wheat.

[00151] The plant, seed, flower, and/or produce thereof may belong to a genus of *Prunus*, *Malus*, *Cynara*, *Musa*, *Hordeum*, *Beta*, *Rubus*, *Vaccinium*, *Brassica*, *Cannabis*, *Capsicum*, *Daucus*, *Apium*, *Citrus*, *Zea*, *Cucumis*, *Curcubita*, *Phoenix*, *Ficus*, *Allium*, *Vitis*, *Elaeis*, *Olea*, *Pisum*, *Pyrus*, *Arachis*, *Carica*, *Carya*, *Pastinaca*, *Diospyros*, *Punica*, *Solanum*, *Cydonia*, *Raphanus*, *Rubus*, *Rosa*, *Oryza*, *Sorghum*, *Glycine*, *Spinacia*, *Fragaria*, *Ipomoea*, *Nicotiana*, *Juglans*, or *Triticum*. The plant, seed, flower, or produce thereof may include a plant or produce thereof can be from the family *Rosaceae*. The plant, flower, seed, or produce thereof from the family *Rosaceae* can be from the genus *Rubus*, such as a raspberry or blackberry, *Fragaria*, such as a strawberry, *Pyrus* such as a pear, *Cydonia* such as a quince, *Prunus*, such as an almond, peach, plum, apricot, cherry or sloe, *Rosa*, such as a rose, or *Malus*, such as an apple. The plant, seed, flower, or produce thereof can be a plant or produce thereof from the family *Ericaceae*. The plant, seed, flower, or produce thereof from the family *Ericaceae* can be from the genus *Vaccinium*, such as a blueberry. The plant, seed, flower, or produce thereof can be a plant or produce thereof from the family *Ericaceae*. The plant, seed, flower, or produce thereof from the family *Ericaceae* can be from the genus *Vaccinium*, such as a blueberry. The plant, seed, flower, or produce thereof can be a plant or produce thereof from the family *Vitaceae*. The plant, seed, flower, or produce thereof from the family *Vitaceae* can be from the genus *Vitis*, such as a grape.

[00152] In one or more embodiments, the plant is an almond tree, apricot tree, apple tree, artichoke plant, banana tree, barley, beet, blackberry plant, blueberry bush, broccoli plant, brassica plant, Brussels sprout plant, cabbage plant, cannabis plant, capsicum plant, carrot plant, celery plant, chard plant, cherry tree, citrus tree, corn stalk, cucurbit plant, cucumber

plant, date palm, fig tree, garlic plant, grape vine, herb plant, spice plant, kale plant, lemon tree, lettuce plant, lime tree, mandarin tree, oil palm, olive tree, onion plant, orange tree, pea shoot, pear tree, peach tree, peanut plant, papaya tree, parsnip plant, pecan tree, persimmon tree, plum tree, pomegranate plant, potato plant, quince plant, radish plant, raspberry plant, rose plant, rice plant, sloe plant, sorghum plant, soybean plant, spinach plant, strawberry plant, sweet potato plant, tobacco plant, tomato vine, turnip greens, walnut tree, or wheat plant.

[00153] In various aspects, the microbe may colonize, or grow, on a portion of the plant. For example, inoculating the plant may produce an endophyte. The microbe may colonize a rhizome of the plant. The microbe may colonize a sucker of the plant. The microbe may be associated with the plant throughout a harvest of portions of the plant. For example, the microbe may colonize a sucker of a subsequent year's crop of the plant. For example, the microbe may colonize a rhizome of the plant between harvests. The microbe may maintain its properties between harvests or growths of new portions of the plant.

[00154] METHOD FOR PRODUCING AN ENDOPHYTE

[00155] In another aspect, embodiments herein relate to a method for producing an endophyte (e.g., an endosymbiont). In some embodiments, the method for producing an endophyte includes one or more steps for using a biocontrol composition as described herein. For example, the method for producing an endophyte may include contacting one or more of a leaf, root, or stem of a plant with *Bacillus amyloliquefaciens* or a formulation including the *Bacillus amyloliquefaciens*. In such embodiments, the contacting produces an endophyte inside the plant or seed. The produced endophyte may protect the plant or seed against a pathogen. In some embodiments, the contacting occurs before the one or more pathogenic organisms are present on or inside the plant, the seed, or the soil comprising the plant.

[00156] In some embodiments, the *Bacillus amyloliquefaciens* is capable of colonizing a rhizome of the plant between harvests, a sucker of a plant crop of a subsequent year, or both. The *Bacillus amyloliquefaciens* may colonize a rhizome of the plant between harvests. The *Bacillus amyloliquefaciens* may colonize a sucker of a subsequent year's

crop of the plant. In some embodiments, the endophyte is transmitted to the progeny of the plant and protects said progeny of the plant against a fungus, bacterium, or nematode. The endophyte may be transmitted via seed germination or via cuttings or transplanting.

[00157] The method for producing an endophyte may include inoculating a plant with a *Bacillus amyloliquefaciens* microbe or a formulation including the *Bacillus amyloliquefaciens* microbe. In some embodiments, inoculating the plant with a *Bacillus amyloliquefaciens* microbe or a formulation including the *Bacillus amyloliquefaciens* microbe allows for the production of an endophyte comprising the *Bacillus amyloliquefaciens*. In some embodiments, the plant includes a banana plant, a Brassica, a lettuce, a blueberry plant, an almond tree, an olive tree, a grape vine, or any combination thereof.

[00158] The microbe may be vertically transmitted from a plant to a plant's progeny. The plant's progeny may be conferred the benefits of the microbe. For example, the endophyte may be transmitted to the progeny of the plant and may protect the progeny of the plant against a fungus, bacterium, nematode, or insect. The transmission to a progeny, or generation of progeny, may comprise seed germination, growth from cuttings, or *via* transplanting.

[00159] In some embodiments, the method of producing an endophyte in a plant enables protection of the plant against a pathogen, such as a fungus, bacterium, or nematode. In some embodiments, the fungus includes *Fusarium*, such as *Fusarium oxysporum*. In some embodiments, the bacterium includes a *Xanthomonas*, such as *Xanthomonas campestris*, a *Xylella* (e.g., *Xylella fastidiosa*), or combinations thereof. In some embodiments, the nematode includes a root-knot nematode or a soybean cyst nematode.

[00160] As used herein, the term "disease severity index" generally refers to a score representing the degree of disease symptoms visible on the plant. For example, a given disease severity index may have a particular number (or range of numbers) of spots on the leaves indicative of a disease. For example, a plant that has more symptoms of the disease has a higher disease severity index than a plant that has a lower disease severity index. Different species of plants may have a different disease severity index associated with it.

[00161] As used herein, the term “disease severity” or “average disease severity” or “percent average disease severity”, generally refers to the degree of disease symptoms which is visible on a plant or population of plants. The disease severity may be calculated by the percentage of the plant that is covered by disease symptoms. The percent average disease severity may be calculated for a population using by assessing the disease severity of each plant and averaging the disease severity of each plant.

[00162] As used herein, the term “disease index”, “average disease index” or “percent average disease index” generally refers to a score for a population of plants representing the degree of disease symptoms visible in a population of plants. The disease index may be calculated as the disease incidence multiplied by the disease severity. The average disease index may be calculated based on a disease severity index or score for an individual plant, number of plants with that disease severity index, the total number of plants, the maximal disease index, and the percent disease incidence in order to create a weighted average representing the average disease severity. In a non-limiting example, a general calculation of the percent average disease index may be done as a
$$\frac{[\text{sum}(\text{number of plants in a given score multiplied by the score})]}{[(\text{total number of plants multiplied by the maximal score})]} \text{ multiplied by } 100.$$

[00163] ADDITIONAL EMBODIMENTS

[00164] Embodiment 1. A method of treatment, comprising:

[00165] inoculating a plant, seed, or soil comprising the plant with a *Bacillus amyloliquefaciens* comprising a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1; wherein the contact reduces growth of a *Fusarium* fungus on the plant, or reduces development of Panama disease on the plant.

[00166] Embodiment 2. The method of embodiment 1, wherein the plant comprises a fruit plant.

[00167] Embodiment 3. The method of embodiment 1, wherein the fruit plant comprises a banana tree.

- [00168] Embodiment 4. The method of embodiment 1, wherein the Panama disease comprises pseudostem disease.
- [00169] Embodiment 5. The method of embodiment 4, wherein the pseudostem disease is reduced by at least 10%.
- [00170] Embodiment 6. The method of embodiment 4, wherein the pseudostem disease is reduced by about 25-75%, relative to a control plant having pseudostem disease and not contacted with the *Bacillus amyloliquefaciens*.
- [00171] Embodiment 7. The method of embodiment 1, wherein the contact comprises contacting a leaf, root, or stem of the plant with the *Bacillus amyloliquefaciens*.
- [00172] Embodiment 8. The method of embodiment 1, wherein the *Fusarium* fungus comprises *Fusarium oxysporum*.
- [00173] Embodiment 9. The method of embodiment 1, wherein nucleic acid comprises a sequence that is 100% identical to SEQ ID NO: 1.
- [00174] Embodiment 10. A method of producing an endophyte, comprising:
- [00175] inoculating a plant with a *Bacillus amyloliquefaciens*, thereby producing the endophyte comprising the *Bacillus amyloliquefaciens*, wherein the plant comprises a banana plant, a Brassica, a lettuce, a blueberry plant, an almond tree, an olive tree, or a grape vine.
- [00176] Embodiment 11. The method of embodiment 10, wherein the *Bacillus amyloliquefaciens* comprises a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1.
- [00177] Embodiment 12. The method of embodiment 11, wherein the sequence of the nucleic acid is 100% identical to SEQ ID NO: 1.
- [00178] Embodiment 13. The method of embodiment 10, wherein the contact comprises contacting a leaf, root, or stem of the plant with the *Bacillus amyloliquefaciens*.
- [00179] Embodiment 14. The method of embodiment 10, wherein the *Bacillus amyloliquefaciens* colonizes a rhizome of the plant between harvests.

- [00180] Embodiment 15. The method of embodiment 10, wherein the *Bacillus amyloliquefaciens* colonizes a sucker of a subsequent year's crop of the plant.
- [00181] Embodiment 16. The method of embodiment 10, wherein the endophyte protects the plant against a pathogen.
- [00182] Embodiment 17. The method of embodiment 16, wherein the pathogen comprises a fungus, bacterium, or nematode.
- [00183] Embodiment 18. The method of embodiment 17, wherein the fungus comprises a *Fusarium*.
- [00184] Embodiment 19. The method of embodiment 18, wherein the *Fusarium* comprises *Fusarium oxysporum*.
- [00185] Embodiment 20. The method of embodiment 17, wherein the bacterium comprises a *Xanthomonas*.
- [00186] Embodiment 21. The method of embodiment 20, wherein the *Xanthomonas* comprises *Xanthomonas campestris*.
- [00187] Embodiment 22. The method of embodiment 17, wherein the bacterium comprises a *Xylella*.
- [00188] Embodiment 23. The method of embodiment 22, wherein the *Xylella* comprises *Xylella fastidiosa*.
- [00189] Embodiment 24. The method of embodiment 17, wherein the nematode comprises a root-knot nematode or a soybean cyst nematode.
- [00190] Embodiment 25. A method of treatment, comprising:
- [00191] inoculating a plant, seed, or soil comprising the plant with a *Bacillus amyloliquefaciens*;
- [00192] wherein the contact reduces growth of *Xanthomonas campestris* on the plant, or reduces blackspot development on the plant.

- [00193] Embodiment 26. The method of embodiment 25, wherein the *Bacillus amyloliquefaciens* comprises a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1.
- [00194] Embodiment 27. The method of embodiment 25, wherein the plant comprises a Brassica or lettuce.
- [00195] Embodiment 28. The method of embodiment 25, wherein the blackspot development is reduced by about 50-85%, relative to a control plant having blackspot and not contacted with the *Bacillus amyloliquefaciens*.
- [00196] Embodiment 29. The method of embodiment 26, wherein the sequence of the nucleic acid is 100% identical to SEQ ID NO: 1.
- [00197] Embodiment 30. A method of treatment, comprising:
- [00198] inoculating a plant, seed, or soil comprising the plant with a *Bacillus amyloliquefaciens* comprising a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1; wherein the contact reduces growth of a *Xanthomonas* bacterium on the plant, or reduces blackspot development on the plant.
- [00199] Embodiment 31. The method of embodiment 30, wherein the *Xanthomonas* bacterium comprises *Xanthomonas campestris*.
- [00200] Embodiment 32. The method of embodiment 30, wherein the plant comprises a lettuce or Brassica.
- [00201] Embodiment 33. The method of embodiment 30, wherein the blackspot development is reduced by at least 10%.
- [00202] Embodiment 34. The method of embodiment 30, wherein the blackspot development is reduced by about 50-85%, relative to a control plant having blackspot and not contacted with the *Bacillus amyloliquefaciens*.
- [00203] Embodiment 35. The method of embodiment 30, wherein the sequence of the nucleic acid is 100% identical to SEQ ID NO: 1.

- [00204] Embodiment 36. A method, comprising: contacting a nematode with a *Bacillus amyloliquefaciens* comprising a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1.
- [00205] Embodiment 37. The method of embodiment 36, wherein the contacting kills, or reduces growth, or reproduction of the nematode.
- [00206] Embodiment 38. The method of embodiment 36, wherein the nematode comprises a root-knot nematode or a soybean cyst nematode.
- [00207] Embodiment 39. The method of embodiment 36, wherein contacting the nematode with the *Bacillus amyloliquefaciens* comprises inoculating a plant comprising the nematode with the *Bacillus amyloliquefaciens*.
- [00208] Embodiment 40. The method of embodiment 36, wherein the contacting inhibits a nematode-mediated plant disease.
- [00209] Embodiment 41. The method of embodiment 36, wherein the sequence of the nucleic acid is 100% identical to SEQ ID NO: 1.
- [00210] Embodiment 42. A method of treatment, comprising: inoculating a plant, seed, or soil comprising the plant with a *Bacillus amyloliquefaciens* comprising a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1; wherein the contact reduces growth of a *Xylella* bacterium on the plant, or reduces development of vascular disease in the plant.
- [00211] Embodiment 43. The method of embodiment 42, wherein the plant comprises a nut tree.
- [00212] Embodiment 44. The method of embodiment 42, wherein the nut tree comprises an almond tree.
- [00213] Embodiment 45. The method of embodiment 42, wherein the plant comprises a fruit plant.
- [00214] Embodiment 46. The method of embodiment 42, wherein the fruit plant comprises an olive tree.

- [00215] Embodiment 47. The method of embodiment 42, wherein the fruit plant comprises a berry plant.
- [00216] Embodiment 48. The method of embodiment 42, wherein the berry plant comprises a blueberry plant.
- [00217] Embodiment 49. The method of embodiment 42, wherein the fruit plant comprises a grape vine.
- [00218] Embodiment 50. The method of embodiment 42, wherein the contact comprises contacting a leaf, root, or stem of the plant with the *Bacillus amyloliquefaciens*.
- [00219] Embodiment 51. The method of embodiment 50, wherein contacting comprises spraying.
- [00220] Embodiment 52. The method of embodiment 42, wherein the *Xylella* bacterium comprises *Xylella fastidiosa*.
- [00221] Embodiment 53. The method of embodiment 42, wherein the vascular disease comprises leaf scorching.
- [00222] Embodiment 54. The method of embodiment 42, wherein the sequence of the nucleic acid is 100% identical to SEQ ID NO: 1.
- [00223] Embodiment 55. A method of treatment, comprising: inoculating a plant, seed, or soil comprising the plant with a *Bacillus amyloliquefaciens*, wherein the plant comprises an almond tree or blueberry plant; and wherein the contact reduces growth of a *Xylella* bacterium on the plant, or reduces development of a vascular disease in the plant.
- [00224] Embodiment 56. The method of embodiment 55, wherein the contact comprises contacting a leaf, root, or stem of the plant with the *Bacillus amyloliquefaciens*.
- [00225] Embodiment 57. The method of embodiment 56, wherein contacting comprises spraying.
- [00226] Embodiment 58. The method of embodiment 55, wherein the *Xylella* bacterium comprises *Xylella fastidiosa*.

- [00227] Embodiment 59. The method of embodiment 55, wherein the vascular disease comprises leaf scorch.
- [00228] Embodiment 60. The method of embodiment 55, wherein the *Bacillus amyloliquefaciens* comprises a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1
- [00229] Embodiment 61. The method of embodiment 60, wherein the sequence of the nucleic acid is 100% identical to SEQ ID NO: 1.
- [00230] Embodiment 62. A method of treatment, comprising: inoculating a plant, seed, or soil comprising the plant with a *Bacillus amyloliquefaciens* comprising a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1; wherein the contact reduces growth of a *Mycosphaerella* fungus on the plant, or reduces development of a leaf spot disease on the plant.
- [00231] Embodiment 63. The method of embodiment 62, wherein the plant comprises a fruit plant.
- [00232] Embodiment 64. The method of embodiment 63, wherein the fruit plant comprises a banana tree.
- [00233] Embodiment 65. The method of embodiment 62, wherein the contact comprises contacting a leaf, root, or stem of the plant with the *Bacillus amyloliquefaciens*.
- [00234] Embodiment 66. The method of embodiment 62, wherein the *Mycosphaerella* fungus comprises *Mycosphaerella fijiensis* or *Mycosphaerella musicola*.
- [00235] Embodiment 67. The method of embodiment 62, wherein the leaf spot disease comprises Black sigatoka.
- [00236] Embodiment 68. The method of embodiment 62, wherein the sequence of the nucleic acid is 100% identical to SEQ ID NO: 1.
- [00237] Embodiment 69. A method of treatment, comprising: inoculating a plant, seed, or soil comprising the plant with a *Bacillus amyloliquefaciens* comprising a nucleic acid

comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1; wherein the plant comprises rice, and the contact reduces development of a rice disease.

[00238] Embodiment 70. The method of embodiment 69, wherein the contact comprises contacting a leaf, root, or stem of the plant with the *Bacillus amyloliquefaciens*.

[00239] Embodiment 71. The method of embodiment 69, wherein the rice disease comprises rice blast, narrow brown spot, brown spot, or sheath blight.

[00240] Embodiment 72. The method of embodiment 69, wherein the rice disease in the plant is reduced by at least 10%, relative to the rice disease in a plant without the contact.

[00241] Embodiment 73. The method of embodiment 69, wherein the sequence of the nucleic acid is 100% identical to SEQ ID NO: 1.

[00242] Embodiment 74. A method of post-harvest protection, comprising: inoculating a harvested crop with a composition comprising the harvested crop with a *Bacillus amyloliquefaciens* comprising a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1, wherein the contact prevents a disease or reduces the incidence and/or severity of a disease.

[00243] Embodiment 75. The method of embodiment 74, wherein the harvested crop is a fruit.

[00244] Embodiment 76. The method of embodiment 75, wherein the fruit is a citrus fruit.

[00245] Embodiment 77. The method of embodiment 76, wherein the citrus fruit is an orange.

[00246] Embodiment 78. The method of embodiment 74, wherein the harvested crop is infected or under threat of infection from at least one of *Fusarium spp.*, *Botrytis spp.*, *Penicillium spp.*, *Geotrichum spp.* and *Rhizoctonia spp.*

[00247] Embodiment 79. The method of embodiment 77, wherein the orange is infected or under threat of infection from *Penicillium digitatum*.

[00248] Embodiment 80. The method of embodiment 79, wherein infection is prevented or disease severity is reduced.

[00249] Embodiment 81. A method of treatment, comprising: inoculating a plant, seed, or soil comprising the plant with a *Bacillus amyloliquefaciens* comprising a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1; wherein the contact reduces growth of a *Phakopsora pachyrhizi* on the plant, or reduces development of soybean rust on the plant.

[00250] EXAMPLES

[00251] The following examples are included for illustrative purposes only and are not intended to limit the scope of the disclosure.

[00252] Example 1: Inhibition of *Xanthomonas campestris* growth in vitro by *Bacillus amyloliquefaciens* BC17B

[00253] The ability of *Bacillus amyloliquefaciens* strain BC17B to inhibit growth *Xanthomonas campestris* was evaluated on R2A medium. BC17B, and *Xanthomonas campestris* (Xc) were cultured in R2A medium for 18 hours. Xc was spread on R2A agar at 1000 cells/plate. 100 μ L (microliters) of BC17B was inoculated into a plug, and inhibition was assessed by measuring zones of clearance on the bacterial lawn, compared to the no-candidate control. BC17B showed clear inhibition of *X. campestris* as shown in FIG. 2. Notably, digital images were taken three days after plating.

[00254] Example 2: Inhibition of *Xanthomonas campestris* growth on detached lettuce leaves by *Bacillus amyloliquefaciens* BC17B

[00255] Bacterial leaf spot control was investigated for BC17B compared to Serenade® Opti (includes 26.2t% of QST713 strain of *Bacillus subtilis*) and a control treatment of phosphate buffered saline (PBS). Treatments were applied to *Xanthomonas campestris*-inoculated lettuce leaf discs. BC17B was applied as a solution in PBS at 8mL (milliliters) of 2.5×10^7 colony forming unit (CFU)/mL on each leaf. Ratings for severity were taken 1, 4, 7, 11, 14, and 18 days after treatment. Experiments were performed in duplicate (disc 1 and disc 2) with 15 replicates per duplicate. The average disease severity of the 15 replicates was taken for each disc at each time point based on a visual rating system between 0 (no disease) to 10 (complete disease cover).

[00256] Results indicated that BC17B in PBS inhibited leaf spot more so than Serenade® Opti (having 26.2% of QST713 strain of *Bacillus subtilis*), including to a statistically significant degree on disc 1. FIG. 3A and FIG. 3B show average disease severity scores for disc 1 and disc 2, respectively. Letters in FIGs. 3A and 3B indicate whether the scores are significantly different for each time point (different letters) or not significantly different (same letter).

[00257] Example 3: *Bacillus amyloliquefaciens* BC17B inhibits lettuce blackspot disease caused by *Xanthomonas campestris*

[00258] Lettuce was seeded into trays of soil that had been inoculated with 1×10^7 CFU/mL of the bacterial pathogen *Xanthomonas campestris*. Two weeks after planting, 10 mL of *Bacillus amyloliquefaciens* BC17B in PBS at 1×10^9 CFU/mL was applied via soil drench to each plant. As controls, (i) PBS was applied at 20 g/a (gallons per acre), or (ii) the biological fungicide Serenade® ASO was applied at 4 qt/a (quart per acre). 15 replicates were evaluated of 3 plants per pot, with blackspot severity assessed on three seedlings per pot.

[00259] FIG. 4A shows the degree of blackspot control for the three experimental conditions at 25 days post-planting. Compared to the PBS control, BC17B in PBS elicited the highest degree of disease control at 72.5%, which was superior to a control that was treated with Serenade® ASO fungicide (having 1.34% of QST713 strain of *Bacillus subtilis*) having 49.7%. FIG. 4B compares the appearance of PBS-treated lettuce and BC17B in PBS-treated lettuce, which shows more dense and fuller plant structure with the BC17B solution treatment as compared to only PBS.

[00260] Example 4: *Bacillus amyloliquefaciens* BC17B inhibits *Botrytis cinerea* on wounded peaches

[00261] The ability of a microbe to protect peaches from *Botrytis cinerea* wound infection was evaluated. The candidate microbe evaluated was *Bacillus amyloliquefaciens* strain BC17B. As noted in Example 1, BC17B is a strain of *Bacillus amyloliquefaciens* that comprises a 16S rRNA sequence provided in SEQ ID NO: 1.

[00262] Four wounds were created on the surface of each peach of 2mm (millimeter) diameter and 1 mm depth. 10 μ L of BC17B at 2×10^8 cells/mL was applied into each wound and the treatment allowed to dry for 4 hours. 10 μ L of Botrytis spores were applied into the wounds (excluding the negative (-) controls) and allowed to dry for 1 hour.

[00263] The peaches were stored in a plastic container with high humidity at room temperature. At day 3, the following properties were assessed: 1) Number of infected wounds; 2) lesion diameters for all the wounds; and 3) weight of disease tissue around wound. The peaches having BC17B treatment showed clear protection from Botrytis infection, as shown in FIG. 5, which includes graphical data for the mean lesion diameter (in millimeters, mm) and the main disease weight (grams, g) for BC17B treated samples, negative controls, and positive controls. The graphs of FIG. 5 show combined means of three experiments.

[00264] Example 5: *Bacillus amyloliquefaciens* BC17B reduces Blossom Blight caused by *Botrytis cinerea* in blueberries

[00265] A field trial was established to test the efficacy of *Bacillus amyloliquefaciens* strain BC17B in a PBS solution against blueberry rot caused by the pathogen *Botrytis cinerea*. BC17B in PBS was applied at a high, medium, and low rate. The volume of product applied was 2 L (liters) for the high rate, 1 L for the medium rate and 500 mL (milliliters) for the low rate.

[00266] The trial was executed in a mature blueberry planting. Botrytis blossom blight incidence was rated on the middle two bushes of each plot at the developmental stage of bloom and start of petal fall.

[00267] Botrytis blossom blight pressure was high and all treatments significantly reduced incidence of disease as shown in FIG. 6. Treatment with a solution of BC17B in PBS reduced disease in a dose-dependent manner, with the high rate reducing blossom blight by 57% compared to the untreated control (UTC). An industry standard chemical treatment completely controlled the disease and resulted in 100% improvement as compared to the UTC.

[00268] Throughout the trial, blueberry bushes were monitored for symptoms of phytotoxicity throughout the season. No symptoms of phytotoxicity were observed.

[00269] Example 6: *Bacillus amyloliquefaciens* BC17B reduces Botrytis, Powdery Mildew, and Downey Mildew on Grape Leaves in the field

[00270] The efficacy of *Bacillus amyloliquefaciens* strain BC17B for control of Botrytis bunch rot, powdery mildew, and downy mildew was evaluated on wine grapes. Negative controls were left untreated. Positive controls and comparison treatments (i.e., “standards”) were treated with Manzate® Max (Fungicide containing Mancozeb 37%, which is a coordination product of zinc, manganese, and ethylenebisdithiocarbamate, obtainable from UPL); Pristine® fungicide (BASF), which includes (carbamic acid, [2-[[[1-(4-chlorophenyl)-1H-pyrazol-3-yl]oxy]methyl]phenyl]methoxy-, methyl ester at 12.8% and 3-pyridinecarboxamide, 2-chloro-N-(4'-chloro(1,1'-biphenyl)-2-yl) at 25.2%); Sovran® 50 WG (Fungicide obtainable from FMC Corporation, and containing 50% (methyl (E)-2-methoxyimino-2-(2-o-tolyloxymethyl)phenyl)acetate); or Rovral® 4F (Fungicide obtainable from FMC Corporation, and containing (3-(3,5-dichlorophenyl)-N-(1-methylethyl)-2,4-dioxo-1-imidazolidinecarboxamide at 41.6%).

[00271] All positive controls were treated in the same manner. The first 2 applications were Manzate® Max (for powdery mildew, 0.56 gal (gallons)) was applied on shoots. These treatments were followed with the Sovran® 50 WG (for downy mildew, 6.4 oz (ounce)), Rovral® 4F (for Botrytis bunch rot, 1.5 pt (pint)), combination of Rovral® 4F 1.5 pt and Vangard® WG (10 oz, Vangard® WG (having 75% of 4-cyclopropyl-6-methyl-N-phenyl-pyrimidinamine and obtainable from Syngenta)); and the combination of Vangard® WG and Pristine®; and then finally, 2 applications of the combination of Fracture® Fungicide (FMC Corporation; includes Banda de Lupinus albus doce (20%), 24.4 fl oz (fluid ounce)), Nufilm® P (Miller Chemical & Fertilizer, LLC; includes 100% Pinene (polyterpenes) polymers, petrolatum, alkyl amine ethoxylate; 0.125%) and Mustang® Maxx (FMC Corporation, includes 9.15 wt% zeta-cypermethrin; 4fl oz).

[00272]

[00273] All treatments received a standard commercial fertility and insecticide program. There were 4 replicates at 3 vines per plot in a randomized plot design. Treatments were applied using a spray boom with 40 g/a for the first 3 applications, and 50 g/a for the last 4 applications, with 7-14 day intervals dependent on growth stages. BC17B was applied at a high, medium, and low rates, corresponding to 9.08×10^{13} CFU/acre, 4.54×10^{13} CFU/acre, and 2.27×10^{13} CFU/acre, respectively.

[00274] Incidence was calculated as the percentage of leaves or clusters with disease, and severity was calculated as percentage area symptomatic on diseased plant parts only. Disease index was calculated as incidence by severity. Data was analyzed through a one-way analysis of variance (ANOVA) and the means were compared using Fisher's least significant difference (LSD). Box plots labeled with the same letter are not significantly different LSD $p=0.05$.

[00275] BC17B was determined to reduce Botrytis, Powdery and Downy Mildew on Grape Leaves in the field in a dose-dependent manner (e.g., as shown in FIGs. 7A-10C). The industry standards as controls provided the most control across all three diseases. In some instances, as shown in FIG. 8B, 8C, 9B, 9C, 10B, and 10C, the higher doses of BC17B demonstrated efficacies reached approximately the efficacies observed for the comparative standard experiments.

[00276] Example 7: *Bacillus amyloliquefaciens* BC17B inhibits downy mildew on cucumbers

[00277] The efficacy of BC17B for control of downy mildew was evaluated on cucumbers. Solutions of the strains were prepared undiluted (concentration of 2×10^8 CFU/mL), diluted 50% v/v, and diluted 25% v/v. All dilutions were made in water. Commercially available biological and chemical fungicides Serenade® Opti and Mancozeb were sprayed at the recommended label rates as controls. After application of all treatments, plants were kept in the lab until dry before inoculation with a spore suspension of downy mildew. Subsequently, plants were kept in a humidity and temperature-controlled growth chamber until rating.

- [00278] Treatments: All treatments were sprayed using an airbrush to ensure even and total coverage of the plants.
- [00279] Plants: Two-week-old Straight Eight cucumber plants (1st true leaf stage) were used for the downy mildew bioassay. Six plants (replicates) were used for each treatment. Downy mildew spores were harvested from heavily infected leaf material. Spore suspension was diluted to 10^5 spores/mL in water before spraying.
- [00280] Growth chamber conditions: Trays of inoculated plants were kept in closed bins with water in the bottom to maintain high humidity. Bins were kept covered for 18-24 hours to ensure infection. Chamber conditions were set to 16 hours light cycle at 17°C.
- [00281] Water treated plants reached an average infection of 100%. FIG. 11 shows percent disease reduction from water controls for the various conditions, with higher bars indicative of better control. BC17B showed dose-dependent efficacy at reducing downy mildew. No other side effects such as phytotoxicity or plant growth promotion were observed.
- [00282] Example 8: *Bacillus amyloliquefaciens* BC17B inhibits *Monilinia fructicola* (brown rot) *in vitro*
- [00283] The efficacy of BC17B for control of *Monilinia fructicola* was evaluated *in vitro* on peach media. From a working spore stock of *Monilinia fructicola*, serial dilutions were made for concentrations 1×10^7 to 1×10^5 spores/mL. Inhibition plug plates were cut for radial growth along with additional control plates for each concentration of spores. For each concentration of *Monilinia* spores, 100 μ L was plated onto agar, and 100 μ L of each *Bacillus amyloliquefaciens* strain (spores, supernatant, or vegetative cells, as indicated in FIG. 12) was inoculated into plugs. Plates were incubated at room temperature. Inhibition was assessed by measuring zones of clearance on the fungal lawn, compared to control (no *Bacillus amyloliquefaciens*).
- [00284] It was observed that BC17B spores effectively inhibited *Monilinia fructicola* (e.g., as shown in FIG. 12). BC17B supernatant represents cell-free fermentate, following centrifugation. In the absence of cells minimal protection was observed.

[00285] Example 9: *Bacillus amyloliquefaciens* BC17B inhibits Panama Wilt caused by *Fusarium oxysporum*

[00286] The ability of *Bacillus amyloliquefaciens* strain BC17B in a PBS solution to inhibit Panama Wilt of Cavendish bananas was evaluated in greenhouse studies. *Bacillus amyloliquefaciens* BC17B solution was prepared at 5×10^9 CFU/mL in PBS.

[00287] Cavendish banana plantlets were removed from pots and placed in sample holders covering the root system, which were then filled with 200 mL of each treatment (*Bacillus amyloliquefaciens* BC17B solution, Propiconazole chemical fungicide, or no treatment). After 30 minutes, plants were removed from sample holders, allowed to dry, then planted in 500 g of potting soil previously infested with *Fusarium oxysporum* var. *cubense* (except for a non-infested negative control condition). 2-5 plantlets were used per condition.

[00288] Plants were placed in a greenhouse with a 16h photoperiod and diurnal temperature range of 79°-86°F. Entire plants were photographed with measuring sticks to assess health and height, and healthy banana leaves were counted and recorded. Pseudostems were first cut 3 inches above soil line and photographed, then removed from the pot, shaken free of soil, cut vertically, and photographed again to assess the remaining pseudostem/corm. Dissected pseudostem photographs were analyzed using software to assess percentages of infected corm.

[00289] It was observed that *Bacillus amyloliquefaciens* BC17B treatment outperformed the chemical Propiconazole fungicide and significantly reduced *Fusarium oxysporum* symptom development in pseudostems as compared to the positive control (e.g., as shown in FIG. 13A and FIG. 13B).

[00290] Example 10: Root-inoculated *Bacillus amyloliquefaciens* BC17B becomes endophytic & epiphytic

[00291] Cavendish banana plantlets were removed from pots and placed in sample holders covering the root system, which were then filled with *Bacillus amyloliquefaciens* BC17B solution (10^9 CFU/mL) to inoculate roots. After 30 minutes, plants were removed from

sample holder, allowed to dry, then planted in 500 g of potting soil. Plants were placed in a greenhouse with a 16h photoperiod and diurnal temperature range of 79°-86°F.

[00292] Samples of leaf, root, and stem were collected, serial dilutions prepared, and the presence and abundance of *Bacillus amyloliquefaciens* BC17B measured by plating on appropriate media.

[00293] FIG. 14A shows the relative abundance of BC17B detected on leaf, root, and stem after 45 days. Controls included plants not treated with BC17B. There was some background detection in control plants due to *Bacillus amyloliquefaciens* strains other than BC17 cross reacting with primers for BC17B. FIG. 14B shows representative images of collected samples and agar plates. These results demonstrate that root-inoculated BC17B becomes endophytic and epiphytic and persists for at least 45 days.

[00294] Example 11: *Bacillus amyloliquefaciens* BC17B protects blueberry plants against the endophytic bacterial pathogen *Xylella fastidiosa*

[00295] The ability of *Bacillus amyloliquefaciens* strain BC17B to protect against the endophytic bacterial pathogen *Xylella fastidiosa* was evaluated for blueberry plants.

[00296] Blueberry pants in single pots were inoculated *via* injection with 5 µl of *Xylella fastidiosa* (10⁸ CFU/mL). The plants were treated with 5 µl of *Bacillus amyloliquefaciens* BC17B (10⁸ CFU/mL, with 0.2 wt% Breakthru® surfactant (obtainable from Evonik) via foliar spray, or 5 µl of PBS.

[00297] A randomized complete block trial design was used in a greenhouse with temperature ranging from 15°C-32°C for up to 16 weeks. Crop response and efficacy against *Xylella* infection severity was assessed weekly after disease incidence became apparent for controls (8-10 wks.). Disease was rated based on percent (%) of symptomatic and asymptomatic leaves per plant.

[00298] It was observed that the BC17B treatment by foliar spray was highly effective at suppressing endophytic disease progression overall and relative to controls as shown in the graph of FIG. 15 showing disease severity over time. Notably, disease was not observed in BC17B-treated plants until approximately day 81.

[00299] Example 12: Evaluating protection against Pierce's Diseases, caused by the bacterial pathogen *Xylella fastidiosa*, in grape plants

[00300] The ability of a solution of *Bacillus amyloliquefaciens* strain BC17B in PBS to protect against the endophytic bacterial pathogen *Xylella fastidiosa* was evaluated for grape plants. Plants were inoculated with *Xylella fastidiosa*, and immediately treated with a PBS solution including *Bacillus amyloliquefaciens* BC17B. Plants were treated with the PBS solution including *Bacillus amyloliquefaciens* BC17B with 5×10^{13} CFU per acre equivalent. The severity of disease was monitored weekly over 20 weeks and the ability of BC17B to protect the plants against disease was evaluated. FIG. 16 shows the disease severity reading over time.

[00301] Plants inoculated with *Xylella fastidiosa* and treated with the BC17B solution showed significantly decreased disease severity and delayed onset when compared to plants inoculated with *Xylella fastidiosa* alone as shown in FIG. 16.

[00302] Example 13: Evaluating protection against Leaf Scorch, as caused by the bacterial pathogen *Xylella fastidiosa* in almond trees

[00303] The ability of a PBS solution of *Bacillus amyloliquefaciens* strain BC17B to protect against the endophytic bacterial pathogen *Xylella fastidiosa* was evaluated for almond trees.

[00304] *Xylella fastidiosa* (Xfa) or *Xylella fastidiosa* sp. *multiplex* (Xfa mpx) was injected at three consecutive nodes on the basal part of stem two year old almond trees in 1 gallon pots. The PBS solution of *Bacillus amyloliquefaciens* strain BC17B was sprayed onto the plants in combination with or without a surfactant, or co-inoculated with *Xylella fastidiosa*. The incidence and severity of disease was monitored, over time, by evaluation of 50 leaves per plant, per treatment, at each time point.

[00305] The incidence (as shown in FIG. 17A-17B) and severity (as shown in FIG. 17C-17D) of Xfa or Xfa mpx symptoms were significantly reduced when the solution of BC17B (tx) was applied by foliar spray. The incidence (as shown in FIG. 17E-17F) and severity

(as shown in FIG. 17G-17H) of Xfa or Xfa mpx symptoms were significantly reduced when the BC17B solution (tx) was injected.

[00306] Example 14: *Bacillus amyloliquefaciens* strain BC17B persists as an epiphyte and endophyte on almond tree stems

[00307] The ability of *Bacillus amyloliquefaciens* strain BC17B to persist as an epiphyte and endophyte on almond trees was evaluated. *Bacillus amyloliquefaciens* strain BC17B in combination with a surfactant was sprayed onto two year old almond trees in 1 gallon pot plants. Plant stem and leaf samples are collected three months post-treatment.

[00308] For epiphyte evaluation, plant tissues with no visible wounds were weighed, added to PBS, saturated for five minutes, and processed for serial dilution plating on semi-selective antibiotic media (with cyclohexamide and polymyxin B) and CFU calculation.

[00309] For endophyte evaluation, plant tissues were washed in 70% ethanol, followed by 8% sodium hypochlorite for 2 minutes, to kill or remove surface organisms. Samples were rinsed with sterile water four times. Plant tissues were crushed in PBS, and then processed for serial dilution plating on semi-selective antibiotic media and CFU calculation. The rinse solution was also plated. Plates were incubated at 37°C for 24 hours, and BC17 CFU enumerated.

[00310] About 7×10^4 CFU/g of BC17B persisted epiphytically on the almond tree stem tissue (as shown in FIG. 18A), and close to 1000 CFU/g endophytically in stem tissue (as shown FIG. 18B). The control included lack of treatment with BC17B. There was some background detection due to *Bacillus amyloliquefaciens* strains other than BC17 cross reacting with primers for BC17B.

[00311] Example 15: *Bacillus amyloliquefaciens* strain BC17B exhibits nematocidal activity in soil

[00312] The ability of a PBS solution of *Bacillus amyloliquefaciens* strain BC17B to reduce nematode load in soil was evaluated. Laboratory jars with 500 g of soil were inoculated with known numbers of root knot nematode. 250 mL of BC17B was applied at 10^8 CFU/mL. As controls, samples were treated with Majestene® (Biological nematicide

having Heat-killed *Burkholderia spp.* strain A396 cells and spent fermentation media (94.46%); 8 qt/a; obtainable from Maronne Bio Innovations, Inc.), or Vydate® L (Chemical nematicide having 24% Oxamyl [Methyl NN -dimethyl-N-[(methyl carbamoyl)Oxy]-I-thiooxamimidate]; 4 pt/a; obtainable from DuPont).

[00313] Samples were collected 6 and 13 days post-application and were subjected to live/dead nematode counts. The BC17B solution treatment led to reduced nematode numbers, including superior control compared to Majestene® treatment as shown in FIG. 19.

[00314] Example 16: *Bacillus amyloliquefaciens* strain BC17B exhibits nematocidal activity on roots

[00315] The ability of a PBS solution of *Bacillus amyloliquefaciens* strain BC17B to reduce nematode load in roots was evaluated in a cucumber seed and plant study.

[00316] 10 mL of the BC17B solution was applied at 10^8 CFU/mL to sterile cucumber seeds. At the time of planting, pots were infected with 165 root knot nematodes per 100 mL of soil. 250 mL of the BC17B solution at 10^8 CFU/mL was applied to soil around plantlets at 3 to 7 day intervals. The plantlets were monitored in a 30 day greenhouse study, with five treatments. Six replicates were included, with four pots per replicate, and two plants per pot. Seedlings scored for root galling; roots were stained to calculate nematode penetration and development. For comparison plants were treated with Majestene® Biological nematicide having Heat-killed *Burkholderia spp.* strain A396 cells and spent fermentation media (94.46%); 8 qt/a; obtainable from Maronne Bio Innovations, Inc.), or Vydate® L (Chemical nematicide having 24% Oxamyl [Methyl NN -dimethyl-N-[(methyl carbamoyl)Oxy]-I-thiooxamimidate]; 4 pt/a; obtainable from DuPont), or a no treatment control.

[00317] Treatment with the BC17B solution was determined to achieve long lasting root protection from root knot nematodes as shown in FIG. 20, including superior control compared to the biological treatment with Majestene®. As such, a 14-day treatment interval was found to be sufficient for root knot nematode control with the PBS solution of BC17B.

[00318] Example 17: Efficacy of *Bacillus amyloliquefaciens* strain BC17B against rice blast, narrow brown spot, brown spot, and sheath blight

[00319] The activity of a PBS solution including *Bacillus amyloliquefaciens* strain BC17B against rice blast, narrow brown spot, brown spot, and sheath blight was evaluated. The BC17B solution was applied by foliar spray twice (at 14-day intervals) to 4 × 215 square foot (ft²) plots. 1 liter of the BC17B solution was applied per spray at a rate of 1.0 × 10¹² CFU acre⁻¹ (CFU/a); at 53.5 gallon per acre (g/a) application volume. For comparison, plots were treated with ARMURE® (Syngenta): 300 g/L, 100 mL acre⁻¹(mL/a); or *Bacillus subtilis*: 1x10⁹ CFU, 1 L acre⁻¹(CFU/[L·a]).

[00320] Foliar disease levels were recorded before the first application timing by visual estimation of the percent area of specified leaves affected by individual diseases on 20 main tillers from across the trial area. Disease incidence was recorded as the percent clusters with greater than or equal to one lesion or colony. Disease severity was recorded as percent symptomatic surface area only on diseased clusters. Disease index was calculated as Disease Incidence × Disease Severity.

[00321] The BC17B solution exhibited very good control of the disease index of rice blast, including comparable or even more consistent control than chemical treatment as shown in FIG. 21. The BC17B solution exhibited very good control of the disease index of narrow brown spot, including comparable control to chemical treatment and superior to *B. subtilis* as shown in FIG. 22. The BC17B solution exhibited very good control of the disease index of brown spot, including comparable control to chemical treatment and superior to *B. subtilis* as shown in FIG. 23. The BC17B solution exhibited very good control of the disease index of sheath blight, including comparable control to chemical treatment and superior to *B. subtilis* as shown in FIG. 24. Phytotoxicity was monitored throughout both seasons, and none was observed.

[00322] Example 18: Efficacy of *Bacillus amyloliquefaciens* strain BC17B against banana fungal disease Black Sigatoka

[00323] An *in vitro* experiment was conducted with *Mycosphaerella musicola*, combined with treatment with a PBS solution including BC17B. Data are shown in FIG. 25A-25B.

The results showed a reduction in spore count by the BC17B solution, are indicative of curative activity by the BC17B solution in plants with black sigatoka.

[00324] An additional *in planta* trial was conducted in a greenhouse to assess the activity of a PBS solution including *Bacillus amyloliquefaciens* strain BC17B against banana fungal disease Black Sigatoka. Shadehouse banana plants were inoculated with *Mycosphaerella fijiensis*. Foliage was treated with foliar sprays of the BC17B-PBS solution, PBS, Serenade®, or Tilt® (Syngenta), at days 0, 14 and 28. The pathogen was applied at 10^4 spores/mL after treatment at day 0 had dried. The solution of BC17B was applied at a concentration of 10^8 CFU/mL until leaves were dripping; other treatments were at the manufacturers recommended doses. All treatments included adjuvants. The plants were monitored for symptoms for 8 weeks after first application of treatment.

[00325] Results from the *in planta* experiment are shown in FIGs. 26A-26B, where different letters indicate statistical differences. Also shown is the area under the curve for plants treated with BC17B that were not infected. In particular, the results show that the BC17B-PBS solution reduced Black Sigatoka to an extent statistically indistinguishable from Tilt®, while crops treated with Serenade® and untreated crops were statistically indistinguishable.

[00326] Example 19: Evaluating protection against bacterial pathogen *Xylella fastidiosa* in olive trees

[00327] The ability of a PBS solution including *Bacillus amyloliquefaciens* strain BC17B to protect against the endophytic bacterial pathogen *Xylella fastidiosa* was evaluated for olive trees.

[00328] *Xylella fastidiosa* was injected at three consecutive nodes on the basal part of stem two year old olive trees in 1 gallon pots. The solution including *Bacillus amyloliquefaciens* strain BC17B was sprayed onto the plants in combination with a surfactant. The incidence and severity of disease was monitored for 28 days after application.

- [00329] Treatment with *Bacillus amyloliquefaciens* strain BC17B in PBS showed significantly lower levels of disease severity (e.g., as shown in FIG. 27A) and incidence (e.g., as shown in FIG. 27B) when compared to a treatment with surfactant alone.
- [00330] Example 20: *Bacillus amyloliquefaciens* BC17B inhibits Panama Wilt caused by *Fusarium oxysporum* in field trials
- [00331] The ability of a PBS solution including *Bacillus amyloliquefaciens* strain BC17B to inhibit Panama Wilt of Cavendish bananas was evaluated in field trials. The *Bacillus amyloliquefaciens* BC17B solution was prepared at 5×10^9 CFU/mL. Acclimatized 45-day-old tissue-culture plantlets of Cavendish banana, grown in a disease-free environment with no contact with FOC, to at least 15 cm high and showed no nutrient deficiency.
- [00332] Plantlets were removed from pots and substrate was removed from the roots, which were then covered with 100 mL per plant with the BC17B solution adjusted to 5×10^8 CFU/mL; or water, or Serenade®. Plants were then removed and allowed to dry for 30 minutes.
- [00333] Plants were maintained in a greenhouse for 4 weeks before transplanting to the infested field in a randomized complete block design (RCBD). Each treatment contained 4 blocks of 10 plants. Treatments over a full year were performed as follows:
- [00334] - BC17B root dip and transplant, with monthly soil drench of 50 mL of an 10^8 CFU/mL of a BC17B solution in PBS per plant.
- [00335] - Water root dip and transplant, with monthly foliar application of PBS with 0.2% Breakthru® surfactant; or
- [00336] - Serenade root dip and transplant with monthly soil drench of 15 mL Serenade® per plant.
- [00337] External evaluation was carried out monthly, and internal evaluation was carried out at the six-month mid-point, sacrificing 2 plants per treatment. Evaluations ranked each plant on the basis of a severity score standardized by a set of images of infected plants.

[00338] FIG. 28A shows the average severity scores for evaluation of internal symptoms of Panama Wilt caused by *Fusarium oxysporum*. Different letters denote statistically different severity scores. FIG. 28B shows representative images of cross-sections of banana plants treated with *Bacillus amyloliquefaciens* BC 17B (left) or water (right). The *Bacillus amyloliquefaciens* BC17B solution treatment statistically significantly reduced *Fusarium oxysporum* symptom development in pseudostems compared with positive control.

[00339] Example 21: *Bacillus amyloliquefaciens* BC17B inhibits *Penicillium digitatum* on post-harvest citrus fruit

[00340] The ability of *Bacillus amyloliquefaciens* strain BC17B to inhibit *Penicillium digitatum* on post-harvest citrus fruit was assessed by zone of clearing on agar media prepared from mandarin fruit extracts. Experiments were performed on standard laboratory medium (PDA) and on two mandarin based media, and images were taken 3 days after plating. In particular, substantial zone of clearing was observed with BC17B as shown in FIG. 29.

[00341] Example 22: *Bacillus amyloliquefaciens* BC17B inhibits Asian Soybean Rust in greenhouses

[00342] Soybean plants were treated, allowed to dry for 2 to 4 hours, then sprayed with a urediniospore suspension (10^5 spores / mL). After inoculation, plants were incubated in high humidity overnight, then placed on a greenhouse bench.

[00343] Results are shown in FIG. 30, where different letters indicate statistical differences. Disease ratings were measured as percent leaf area covered by lesions. An average of 10 plants were used for each treatment. It was observed that solutions including BC17B reduced Asian soybean rust to an extent comparable with Proline, a common chemical control agent.

[00344] Example 23: *Bacillus amyloliquefaciens* BC17B is stable when produced in spore form

[00345] BC17B was prepared as spores and stored in PBS at 54°C for two weeks. Viable CFU counts were determined at 0, 7, and 14 days. Antifungal activity was assessed in a

confrontation assay with *Botrytis cinerea*. The spore solution of BC17B showed no loss of viability or efficacy after two weeks at 54°C (e.g., as shown in FIGs. 31A and 31B).

[00346] While preferred embodiments of the present disclosure have been shown and described herein, it will be obvious to those skilled in the art that such embodiments are provided by way of example only. Numerous variations, changes, and substitutions will now occur to those skilled in the art without departing from the disclosure. It should be understood that various alternatives to the embodiments of the disclosure described herein may be employed in practicing the disclosure. It is intended that the following claims define the scope of the disclosure and that methods and structures within the scope of these claims and their equivalents be covered thereby.

[00347] Throughout the application, ordinal numbers (for example, first, second, third) may be used as an adjective for an element (that is, any noun in the application). The use of ordinal numbers does not imply or create a particular ordering of the elements or limit any element to being only a single element unless expressly disclosed, such as by the use of the terms “before,” “after,” “single,” and other such terminology. Rather, the use of ordinal numbers is to distinguish between the elements. By way of an example, a first element is distinct from a second element, and the first element may encompass more than one element and succeed (or precede) the second element in an ordering of elements.

[00348] It is to be understood that the singular forms “a,” “an,” and “the” include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to “a horizontal beam” includes reference to one or more of such beams.

[00349] Terms such as “approximately” or “substantially” mean that the recited characteristic, parameter, or value need not be achieved exactly, but that deviations or variations, including, for example, tolerances, measurement error, measurement accuracy limitations, and other factors known to those of skill in the art, may occur in amounts that do not preclude the effect the characteristic was intended to provide.

[00350] It is to be understood that one or more of the steps shown in the flowcharts may be omitted, repeated, or performed in a different order than shown. Accordingly, the scope

disclosed should not be considered limited to the specific arrangement of steps shown in the flowcharts.

[00351] Although multiple dependent claims are not introduced, it would be apparent to one of ordinary skill that the subject matter of the dependent claims of one or more embodiments may be combined with other dependent claims.

[00352] Although only a few example embodiments have been described in detail above, those skilled in the art will readily appreciate that many modifications are possible in the example embodiments without materially departing from this invention. For example, any aspect or embodiment described herein can be combined with any other aspect or embodiment as disclosed herein. Accordingly, all such modifications are intended to be included within the scope of this disclosure as defined in the following claims.

CLAIMS

What is claimed:

1. A formulation comprising:
a cell of *Bacillus amyloliquefaciens* strain BC17B (ATCC Accession Deposit Number: PTA-127137).
2. A method comprising:
contacting a plant, a seed, or soil comprising a plant with a formulation, wherein the formulation comprises:
Bacillus amyloliquefaciens comprising a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1, and/or one or more molecules synthesized by said *Bacillus amyloliquefaciens*; and
an aqueous solution, wherein the formulation has a pH in a range from about 6 to about 11;
wherein the contacting reduces growth of or kills, one or more pathogenic organisms present on or inside the plant, the seed, or the soil comprising the plant, wherein the one or more pathogenic organisms is selected from the group consisting of a fungus, a bacterium, and a nematode.
3. The method of claim 2, further comprising:
preparing the formulation by adding an amount of (i) the *Bacillus amyloliquefaciens*, and/or (ii) the one or more molecules synthesized by the *Bacillus amyloliquefaciens*, to an amount of the aqueous solution.
4. The method of claim 3, wherein a colony forming unit of the amount of (i) the *Bacillus amyloliquefaciens*, and/or (ii) the one or more molecules synthesized by the *Bacillus amyloliquefaciens* in the formulation is 1×10^5 CFU/mL or greater.
5. The method of claim any one of claims 2 to 4, wherein the one or more pathogenic organisms causes an infection inside the plant.

6. The method of any one of claims 2 to 5, wherein the one or more pathogenic organisms comprises an infectious fungus that belongs to a genus selected from the group consisting of *Phakopsora*, *Magnaporthe*, *Cochliobolus*, *Sphaerulina*, *Geotrichum*, *Microsphaera*, *Blumeria*, *Podosphaera*, *Peronospora*, *Colletotrichum*, and *Pseudoperonospora*.
7. The method of claim 6, wherein the infectious fungus is *Phakopsora pachyrhizi*, *Magnaporthe grisea*, *Cochliobolus miyabeanus*, *Sphaerulina oryzae*, *Geotrichum spp*, *Microsphaera diffusa*, *Blumeria graminis*, *Podosphaera leucotricha*, *Peronospora manshurica*, *Peronospora effusa*, *Peronospora belbahrii*, *Colletotrichum musae*, or *Pseudoperonospora cubensis*.
8. The method of claim 6 or 7, wherein the contacting prevents a disease or reduces the incidence and/or severity of a disease of the plant, and the disease in the plant is reduced by at least 10%, *e.g.*, about 50-85%, relative to a control plant having the disease and not contacted with the *Bacillus amyloliquefaciens*.
9. The method of claim 8, wherein the disease comprises Asian soybean rust, rice blast, brown spot, narrow brown spot, crown rot or sour rot (citrus, post-harvest).
10. The method of any one of claims 2 to 9, wherein the one or more pathogenic organisms is a bacterium.
11. The method of claim 10, wherein the bacterium belongs to a genus of *Xanthomonas* or *Xylella*.
12. The method of claim 10 or 11, wherein the contacting prevents a disease or reduces the incidence and/or severity of a disease of the plant, and the disease in the plant is reduced by at least 10%, *e.g.*, about 50-85%, relative to a control plant having the disease and not contacted with the *Bacillus amyloliquefaciens*.
13. The method of claim 12, wherein the disease comprises olive quick decline syndrome, Pierce's disease (grapes), leaf scorch (almonds, coffee), citrus variegated chlorosis, or Black rot.

14. The method of any one of claims 2 to 5, wherein the contacting kills, or reduces growth, or reproduction of a nematode.
15. The method of claim 14, wherein the nematode belongs to the genus *Heterodera* or *Meloidogyne*.
16. The method of claims 14 or 15, wherein the contacting prevents a disease or reduces the incidence and/or severity of a disease of the plant, and the disease in the plant is reduced by at least 10%, *e.g.*, about 50-85%, relative to a control plant having the disease and not contacted with the *Bacillus amyloliquefaciens*, relative to a control plant having the disease and not contacted with the *Bacillus amyloliquefaciens*.
17. The method of claim 16, wherein the disease comprises soybean cysts or root knots.
18. The method of any one of claims 2 to 17, wherein the contacting comprises contacting a leaf, root, fruit, seed, flower, or stem of the plant with the *Bacillus amyloliquefaciens*.
19. The method of claim 18, wherein contacting comprises dusting, dipping, rolling, injecting, rubbing, spraying, or brushing.
20. The method of any one of claims 2 to 19, wherein the *Bacillus amyloliquefaciens* colonizes a rhizome of the plant between harvests.
21. The method of any one of claims 2 to 20, wherein the *Bacillus amyloliquefaciens* comprises a spore.
22. The method of any one of claims 2 to 21, wherein the contacting produces an endophyte inside the plant or seed, the endophyte protects the plant or seed against a pathogen.
23. The method of any one of claims 2 to 22, further comprising: providing the *Bacillus amyloliquefaciens* in a stable formulation.
24. The method of claim 23, wherein the stable formulation comprises viable *Bacillus amyloliquefaciens* after storage at a temperature of up to about 50°C for 14 days.

25. The method of claim 23 or 24, wherein the stable formulation comprises a reduction of efficacy of *Bacillus amyloliquefaciens* of no more than 10%, after storage at a temperature of up to about 50°C for 14 days.
26. The method of any one of claims 23 to 25, wherein the stable formulation comprises a reduction of number of viable *Bacillus amyloliquefaciens* of no more than 10%, after storage at a temperature of up to about 50°C for 14 days.
27. The method of any one of claims 23 to 26, wherein the stable formulation is at a pH of from about 6 to about 8.
28. The method of any one of claims 23 to 27, wherein the stable formulation comprises an osmotic concentration of about 0.1 mM, about 1 mM, about 10 mM, about 100 mM, or about 1 M solute.
29. The method of any one of claims 2 to 28, wherein the one or more molecules comprise lipopeptides, polyketides, peptides, dipeptides, polypeptides, cyclic polypeptides, polyenes, aminoglycosides, surfactants or siderophores.
30. The method of any of claims 1 to 29, wherein the one or more molecules comprises an antibiotic.
31. The method of claim 29 or 30, wherein the molecule synthesized by the *Bacillus amyloliquefaciens* comprises a lipopeptide selected from the group consisting of fengycin, plipastatin, and surfacticin.
32. The method of claim 29 or 30, wherein the molecule synthesized by the *Bacillus amyloliquefaciens* comprises a polyketide selected from the group consisting of macrolactin H and difficidin.
33. The method of claim 29 or 30, wherein the molecule synthesized by the *Bacillus amyloliquefaciens* comprises a peptide selected from the group consisting of bacilysin and rhizocticin A.

34. The method of claim 29 or 30, wherein the molecule synthesized by the *Bacillus amyloliquefaciens* comprises an aminoglycoside selected from the group consisting of butirosin A and butirosin B.
35. The method of claim 29 or 30, wherein the molecule synthesized by the *Bacillus amyloliquefaciens* comprises bacillibactin.
36. The method of any one of claims 29 or 30, wherein the molecule synthesized by the *Bacillus amyloliquefaciens* comprises surfactin.
37. The method of any of claims 2 to 36, wherein the one or more molecules are secreted by the *Bacillus amyloliquefaciens* into a liquid comprising the *Bacillus amyloliquefaciens*, and wherein the contacting comprises contacting the liquid with the plant, the seed, or the soil comprising the plant and/or contacting a fraction isolated or purified from the liquid and comprising the one or more molecules with the plant, the seed, or the soil comprising the plant.
38. The method of any one of claims 2 to 37, further comprising, prior to contacting, purifying the one or more small molecules.
39. The method of any one of claims 2 to 38 further comprising steps of:
harvesting a crop from the plant, and
contacting the harvested crop with the formulation comprising a *Bacillus amyloliquefaciens* comprising a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1.
40. A formulation comprising:
a *Bacillus amyloliquefaciens* spore comprising a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1,
wherein the formulation has a pH in a range from about 6 to about 11, and
wherein the formulation comprises viable *Bacillus amyloliquefaciens* after storage at a temperature of from about 18°C to about 25°C or at a temperature of up to about 50°C for at least 14 days.

41. The formulation of claim 40, wherein the fungus, bacterium, or nematode comprises one or more pathogenic organisms belonging to a genus of *Phakopsora*, *Magnaporthe*, *Cochliobolus*, *Sphaerulina*, *Geotrichum*, *Microsphaera*, *Blumeria*, *Podosphaera*, *Peronospora*, *Pseudoperonospora*, *Xanthomonas*, *Xylella*, *Heterodera*, *Colletotrichum*, or *Meloidogyne*.
42. The formulation of claim 40 or 41, wherein the formulation comprises a reduction of efficacy of *Bacillus amyloliquefaciens* of no more than 10%, after storage at a temperature of up to about 50°C for 14 days.
43. The formulation of any one of claims 40 to 42, wherein the formulation comprises a reduction of number of viable *Bacillus amyloliquefaciens* of no more than 10% after storage at a temperature of up to about 50°C for 14 days.
44. The formulation of any one of claims 40 to 43, wherein the formulation is at a pH of from about 6 to about 8.
45. The formulation of any one of claims 40 to 44, wherein the formulation comprises an osmotic concentration of 0.1 mM, about 1 mM, about 10 mM, about 100 mM, or about 1 M solute.
46. A method for treating a disease in a plant, a seed, or soil comprising a plant, the method comprising steps of:
obtaining a plant, a seed, or soil comprising a plant having a disease; and
contacting the plant, the seed, or soil comprising the plant with a formulation comprising:
 (i) a *Bacillus amyloliquefaciens* comprising a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1, and/or
 (ii) one or more molecules synthesized by said *Bacillus amyloliquefaciens*;
wherein the formulation has a pH in a range from about 6 to about 11;
wherein the contacting reduces growth of or kills, one or more pathogenic organisms present on or inside the plant, the seed, or the soil comprising the plant and responsible for the disease;

wherein the disease is Asian soybean rust, rice blast, brown spot, narrow brown spot, crown rot, sour rot (citrus, post-harvest), olive quick decline syndrome, Pierce's disease (grapes), leaf scorch (almonds, coffee), citrus variegated chlorosis, Black rot, soybean cysts, or root knots.

47. A method for preventing or reducing severity of a disease in a plant, a seed, or soil comprising a plant, the method comprising steps of:

obtaining a plant, a seed, or soil comprising a plant at risk for contracting a disease and contacting the plant, the seed, or soil comprising the plant with a formulation comprising:

- (i) a *Bacillus amyloliquefaciens* comprising a nucleic acid comprising a sequence that is at least 99.8% identical to SEQ ID NO: 1, and/or
- (ii) one or more molecules synthesized by said *Bacillus amyloliquefaciens*;

wherein the formulation has a pH in a range from about 6 to about 11;

wherein the contacting reduces growth of or kills, one or more pathogenic organisms present on or inside the plant, the seed, or the soil comprising the plant and responsible for the disease;

wherein the disease is Asian soybean rust, rice blast, brown spot, narrow brown spot, crown rot, sour rot (citrus, post-harvest), olive quick decline syndrome, Pierce's disease (grapes), leaf scorch (almonds, coffee), citrus variegated chlorosis, Black rot, soybean cysts, or root knots.

48. The method of claim 47, wherein the contacting comprises contacting a leaf, root, fruit, seed, flower, or stem of the plant with the *Bacillus amyloliquefaciens*.

49. The method of claim 47 or 48, wherein the *Bacillus amyloliquefaciens* comprises a spore.

50. The method of any one of claims 47 to 49, wherein the contacting produces an endophyte inside the plant or seed.

51. The method of any one of claims 47 to 50, wherein the contacting occurs before the one or more pathogenic organisms are present on or inside the plant, the seed, or the soil comprising the plant.

52. The method of any one of claims 47 to 51, wherein the one or more molecules are secreted by the *Bacillus amyloliquefaciens* into a liquid comprising the *Bacillus amyloliquefaciens*, and wherein the contacting comprises contacting the liquid with the plant, the seed, or the soil comprising the plant and/or contacting a fraction isolated or purified from the liquid and comprising the one or more molecules with the plant, the seed, or the soil comprising the plant.

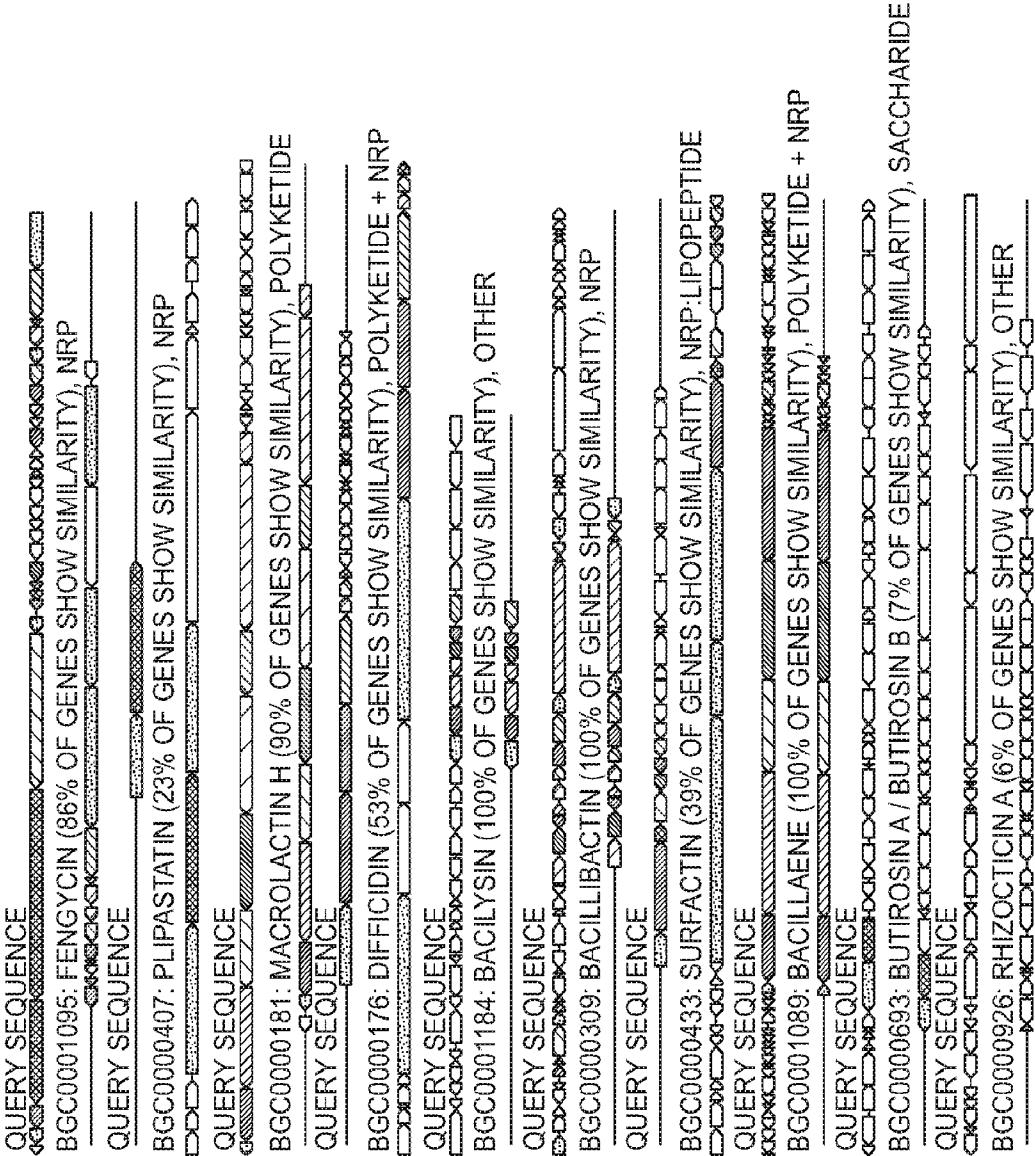
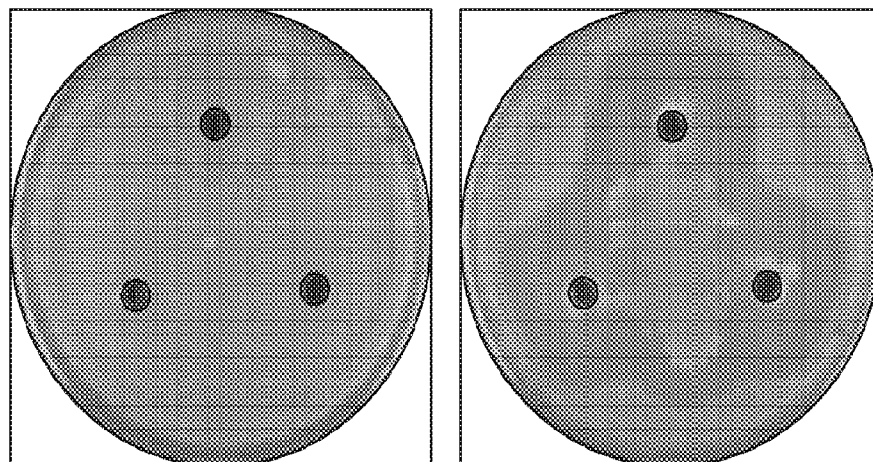


FIG. 1

COMPOUND	% GENE CLUSTER SIMILARITY
FENGYCIN	86
PLIPASTATIN	26
MACROLACTIN H	90
DIFFICIDIN	53
BACILYSIN	100
BACILLIBACTIN	100
SURFACTIN	39
BACILLAENE	100
BUTIROSIN A / B	7
RHIZOCTICIN A	6



Xcc Control
(1000 Cells)

BC17

Photos Shown 3 Days Post Plating

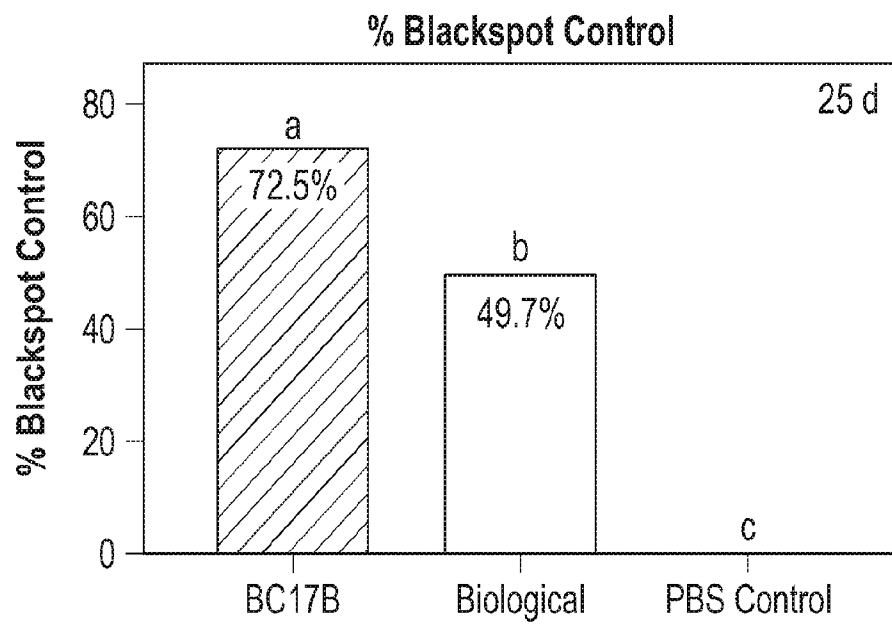
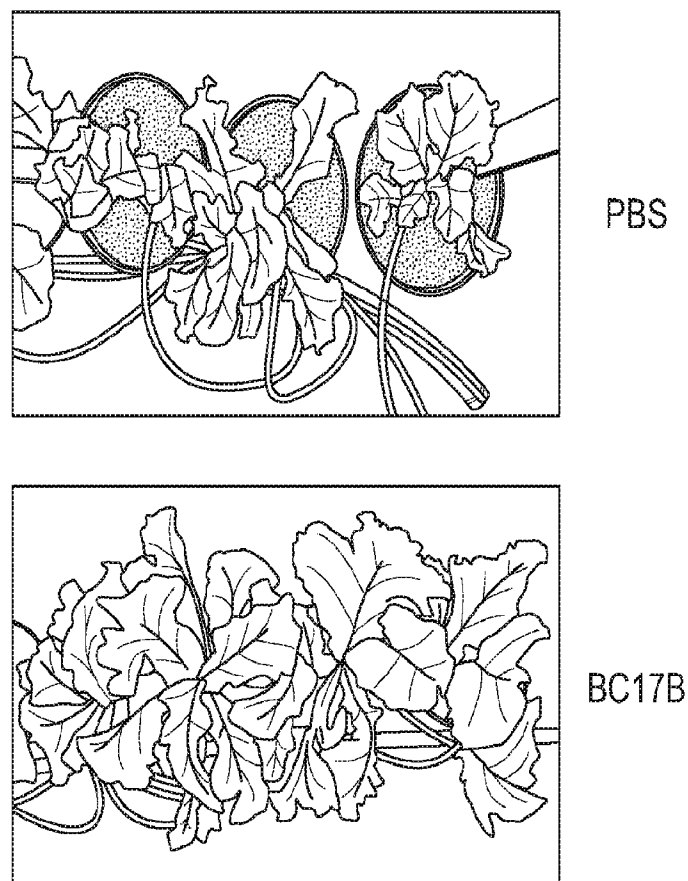
FIG. 2

Trt No.	Treatment Name	4/10/2020 1 DA-A	4/13/2020 4 DA-A	4/16/2020 7 DA-A	4/20/2020 11 DA-A
1	Phosphate Buffer Saline	0.00 a	0.00 a	0.50 a	2.40 a
2	Serenade OPTI	0.00 a	0.00 a	0.10 a	1.80 b
3	BC17	0.00 a	0.00 a	0.20 a	0.60 c

FIG. 3A

Trt No.	Treatment Name	4/10/2020 1 DA-A	4/13/2020 4 DA-A	4/16/2020 7 DA-A	4/20/2020 11 DA-A
1	Phosphate Buffer Saline	0.00 a	0.00 a	0.40 a	1.80 a
2	Serenade OPTI	0.00 a	0.00 a	0.30 a	1.10 b
3	BC17	0.00 a	0.00 a	0.10 a	0.70 b

FIG. 3B

**FIG. 4A****FIG. 4B**

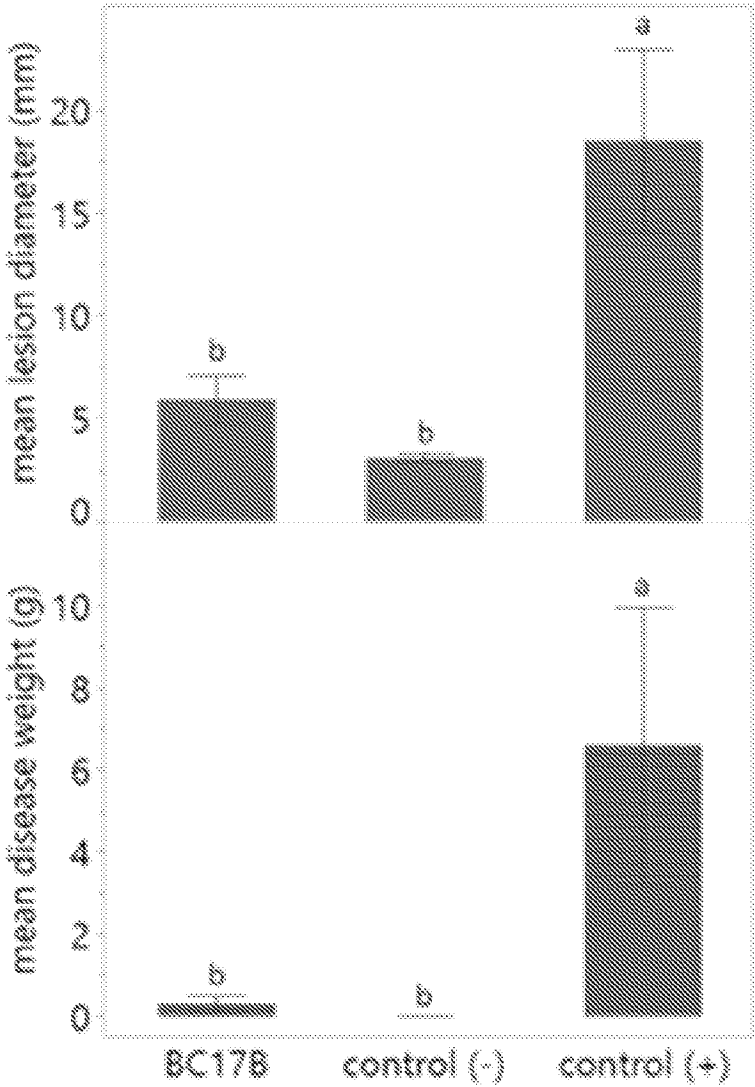


FIG. 5

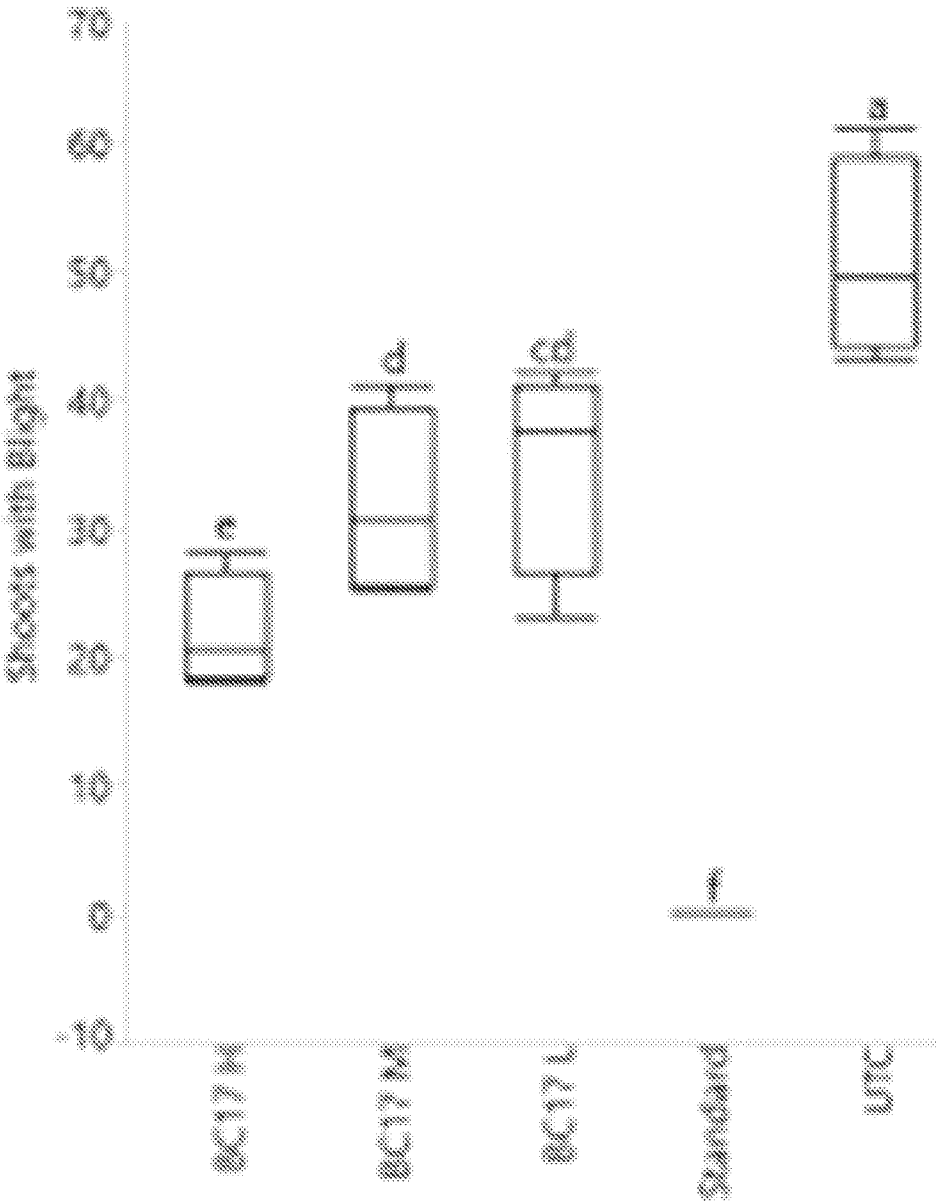


FIG. 6

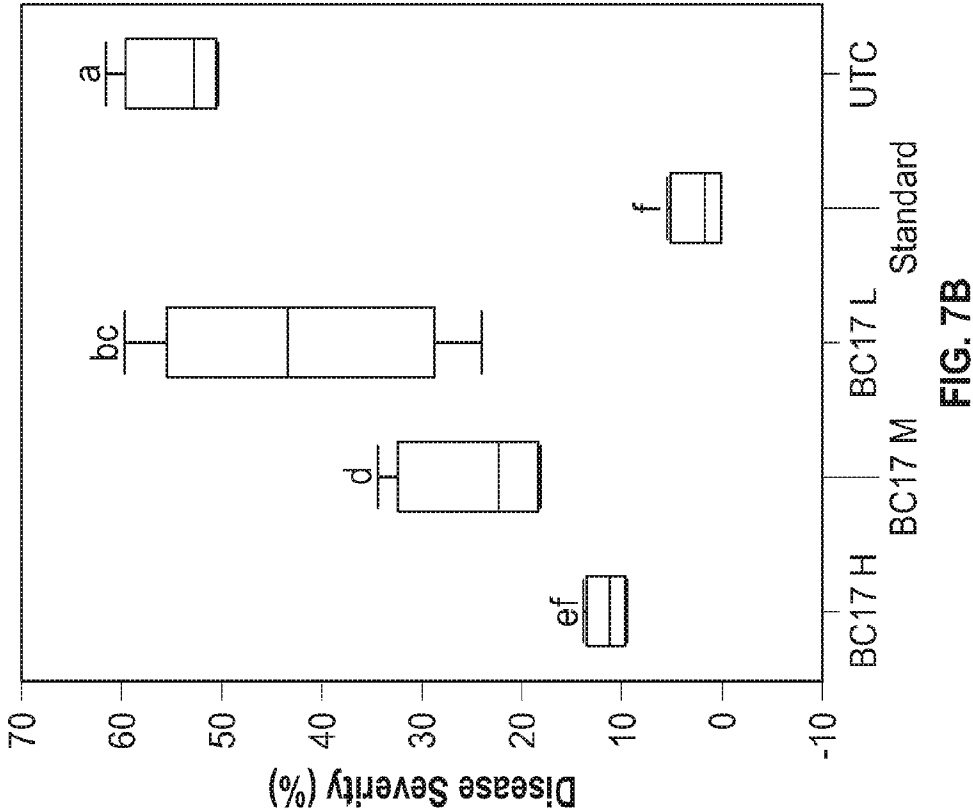


FIG. 7B

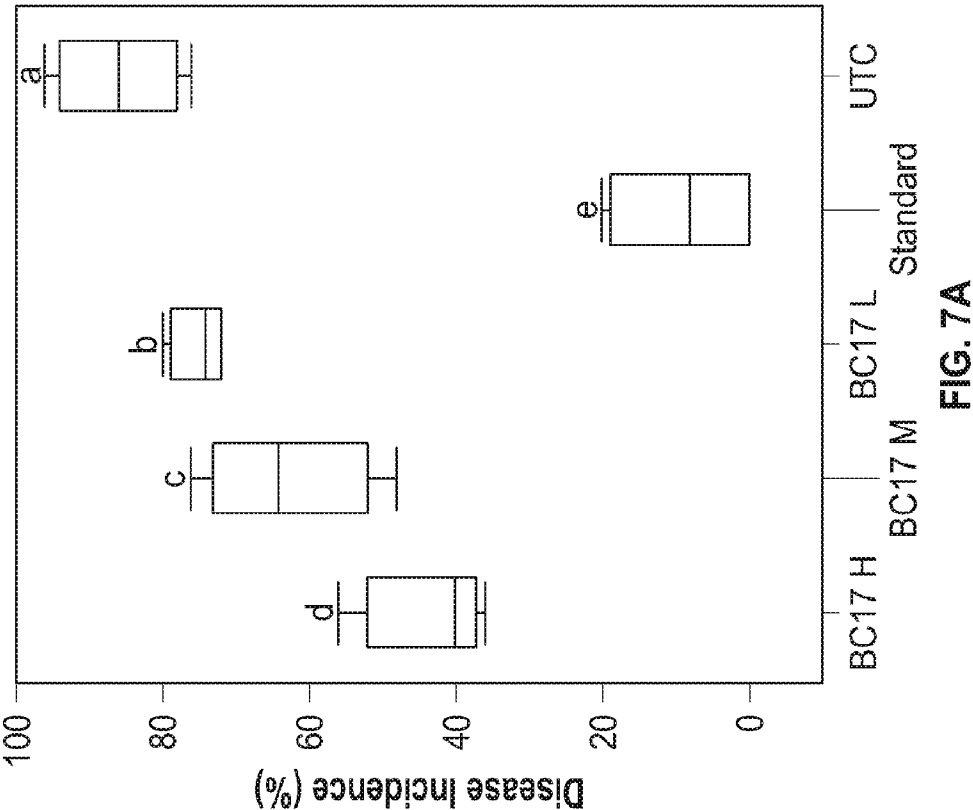


FIG. 7A

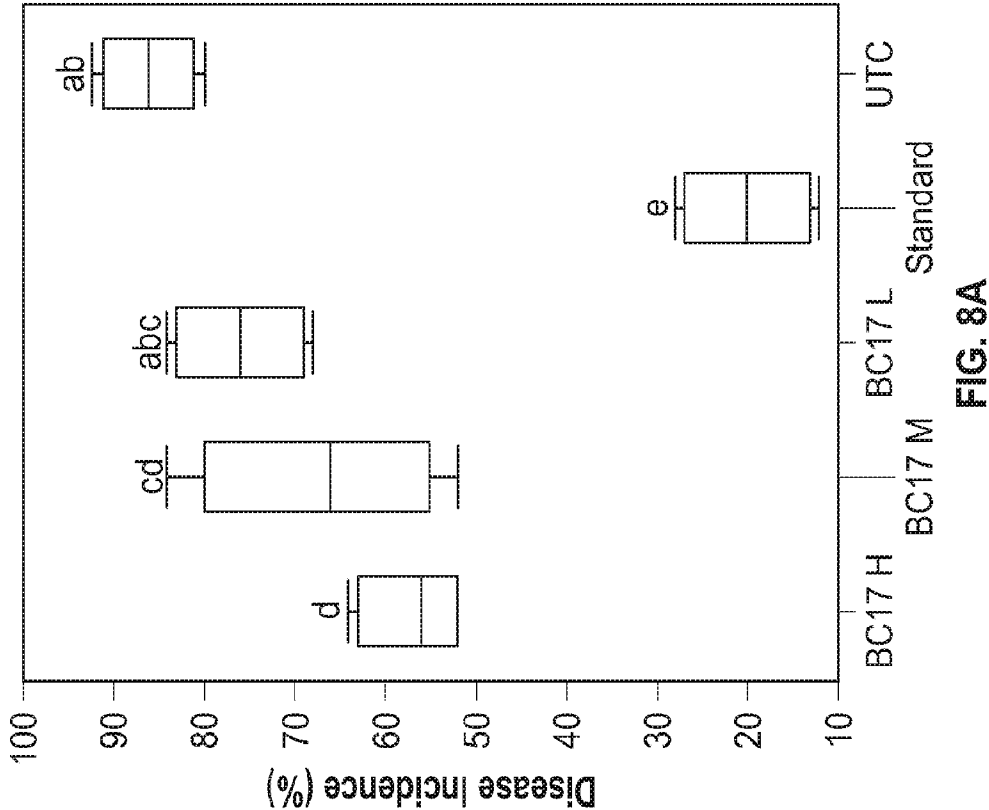


FIG. 8A

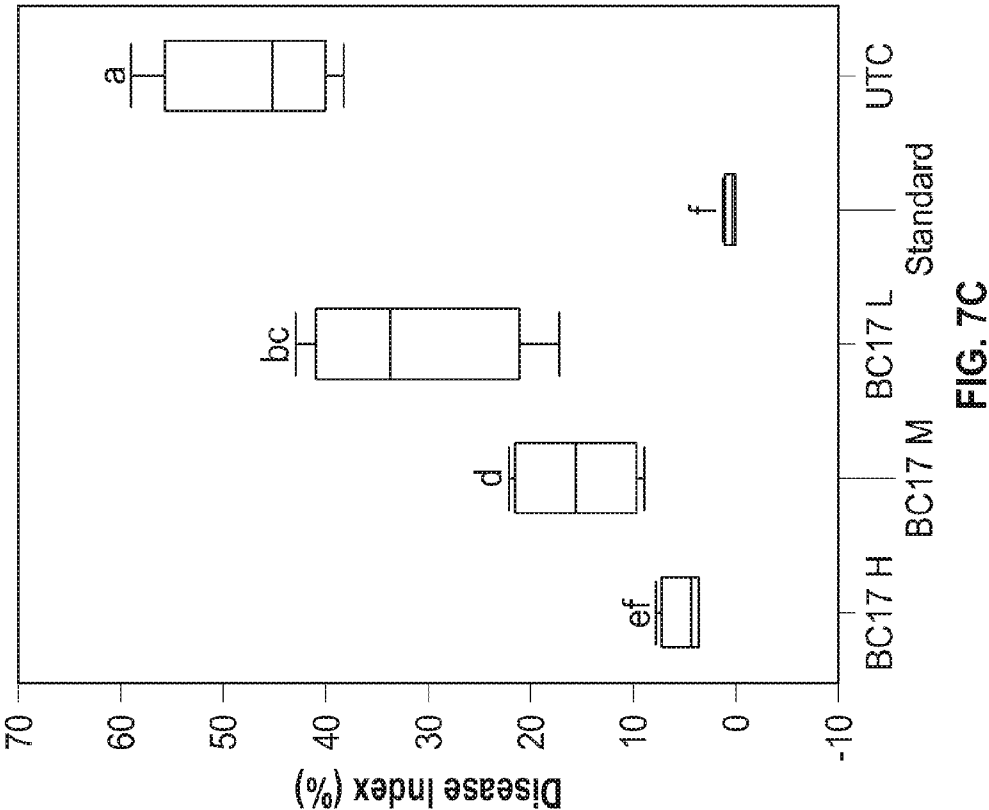


FIG. 7C

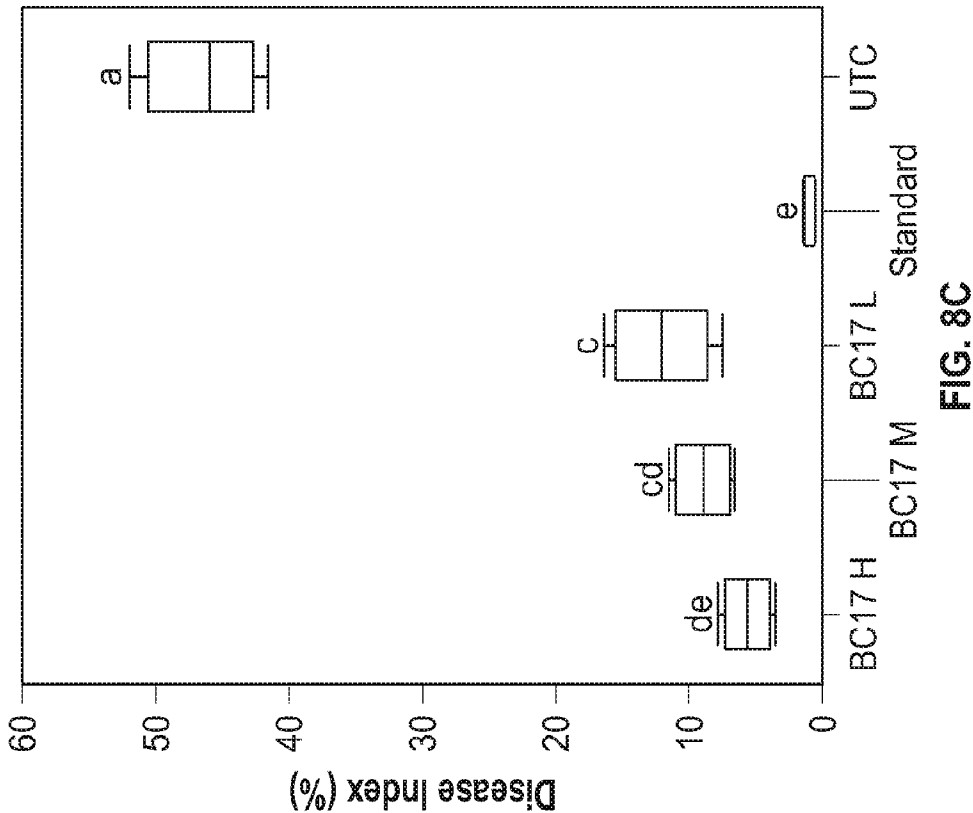


FIG. 8C

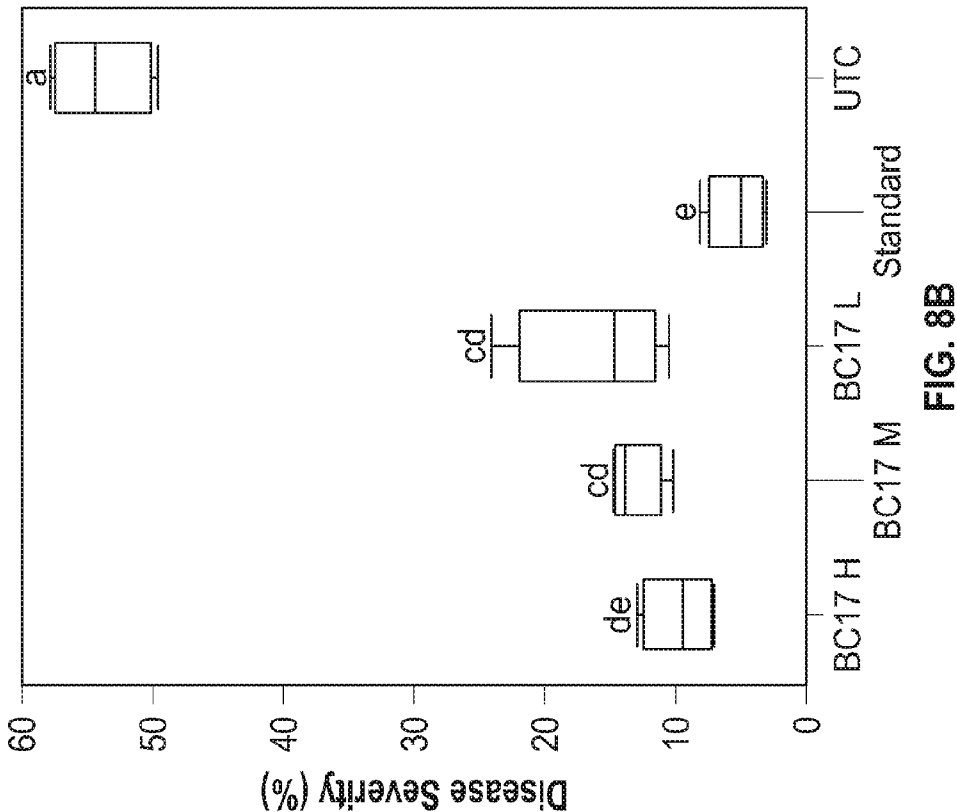


FIG. 8B

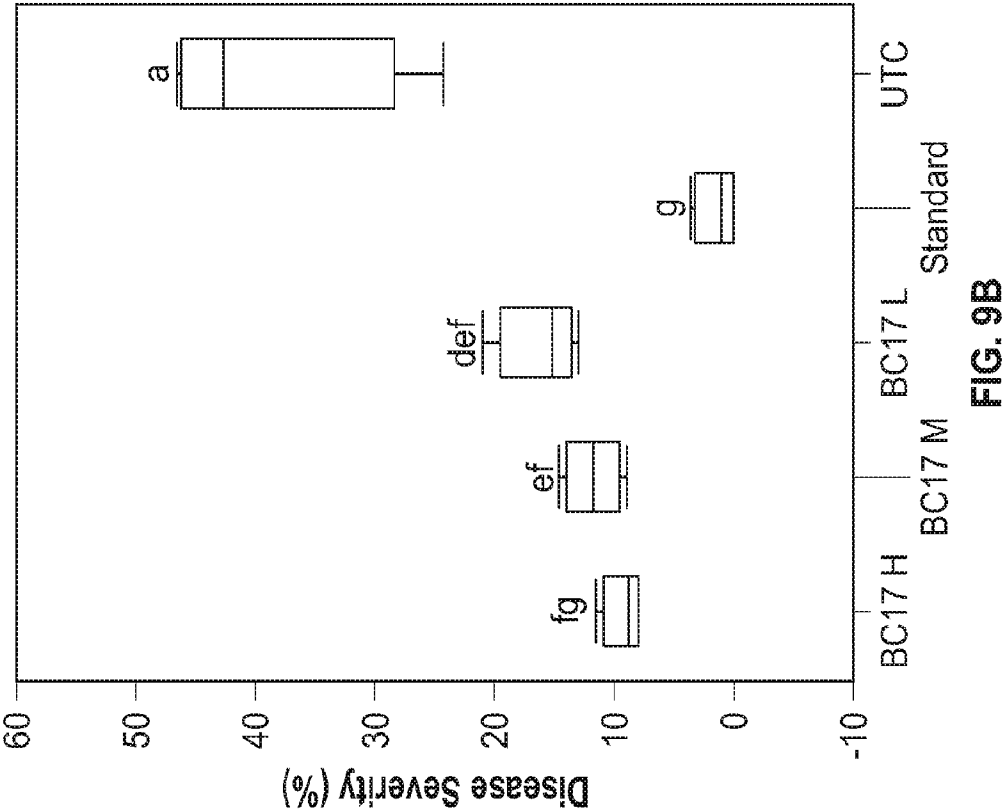


FIG. 9B

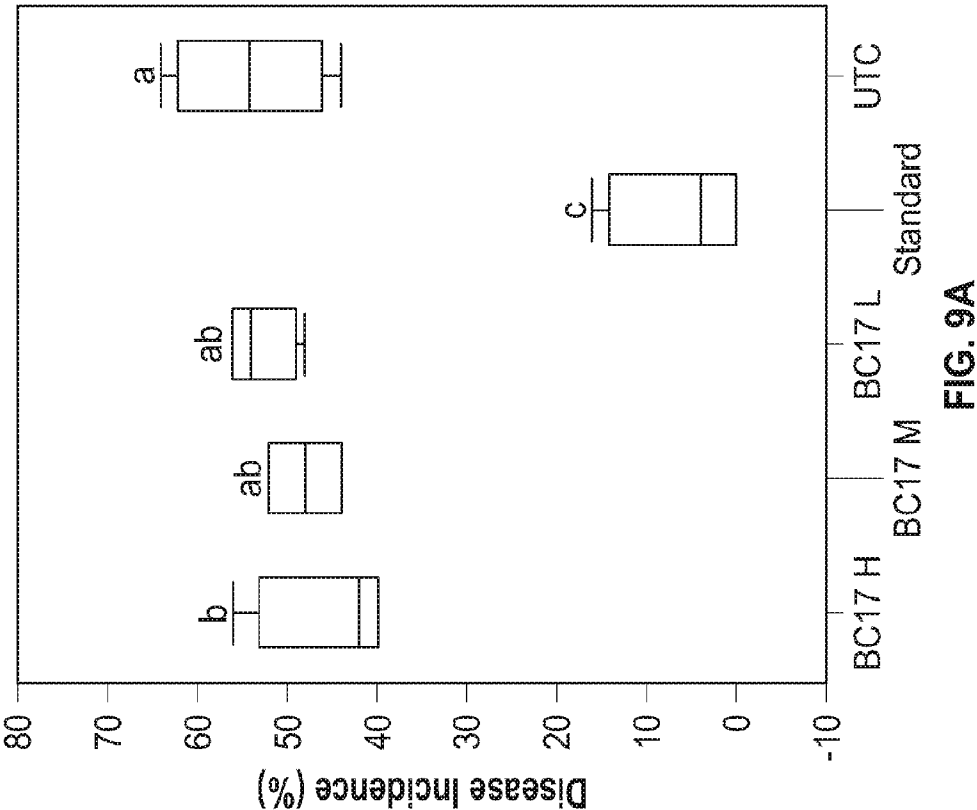


FIG. 9A

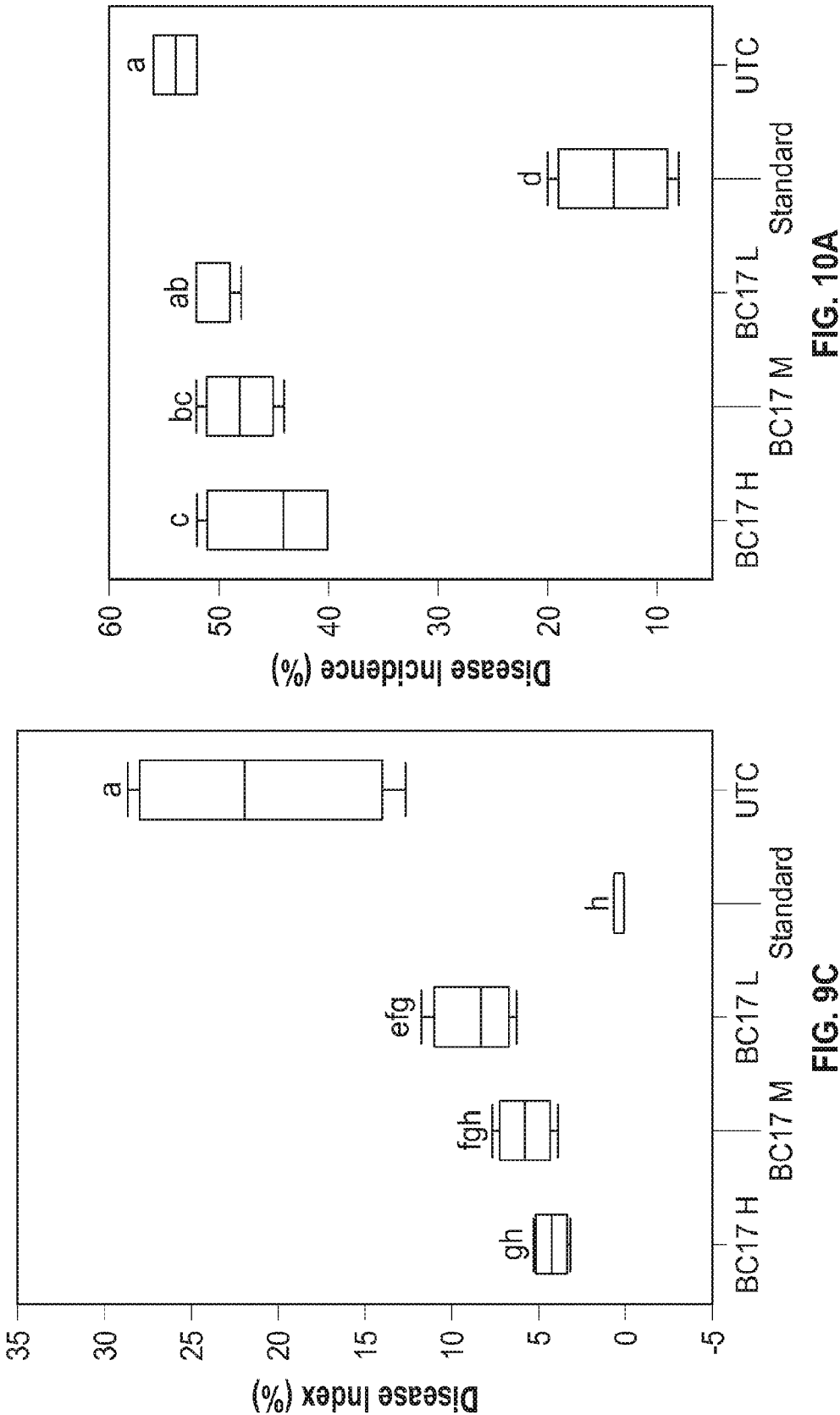


FIG. 9C

FIG. 10A

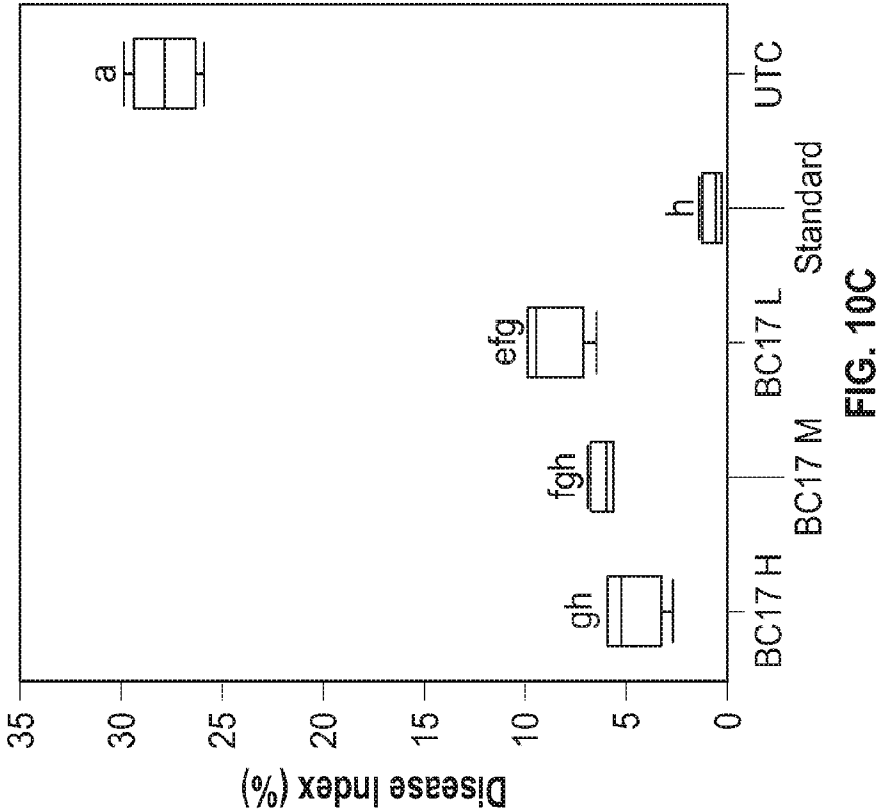


FIG. 10C

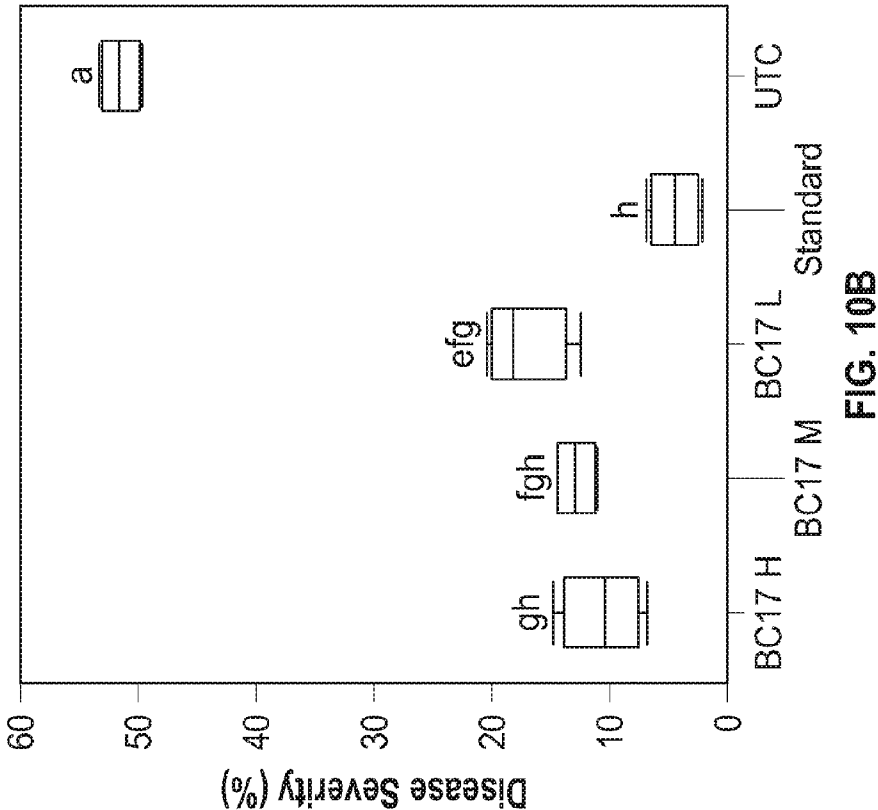


FIG. 10B

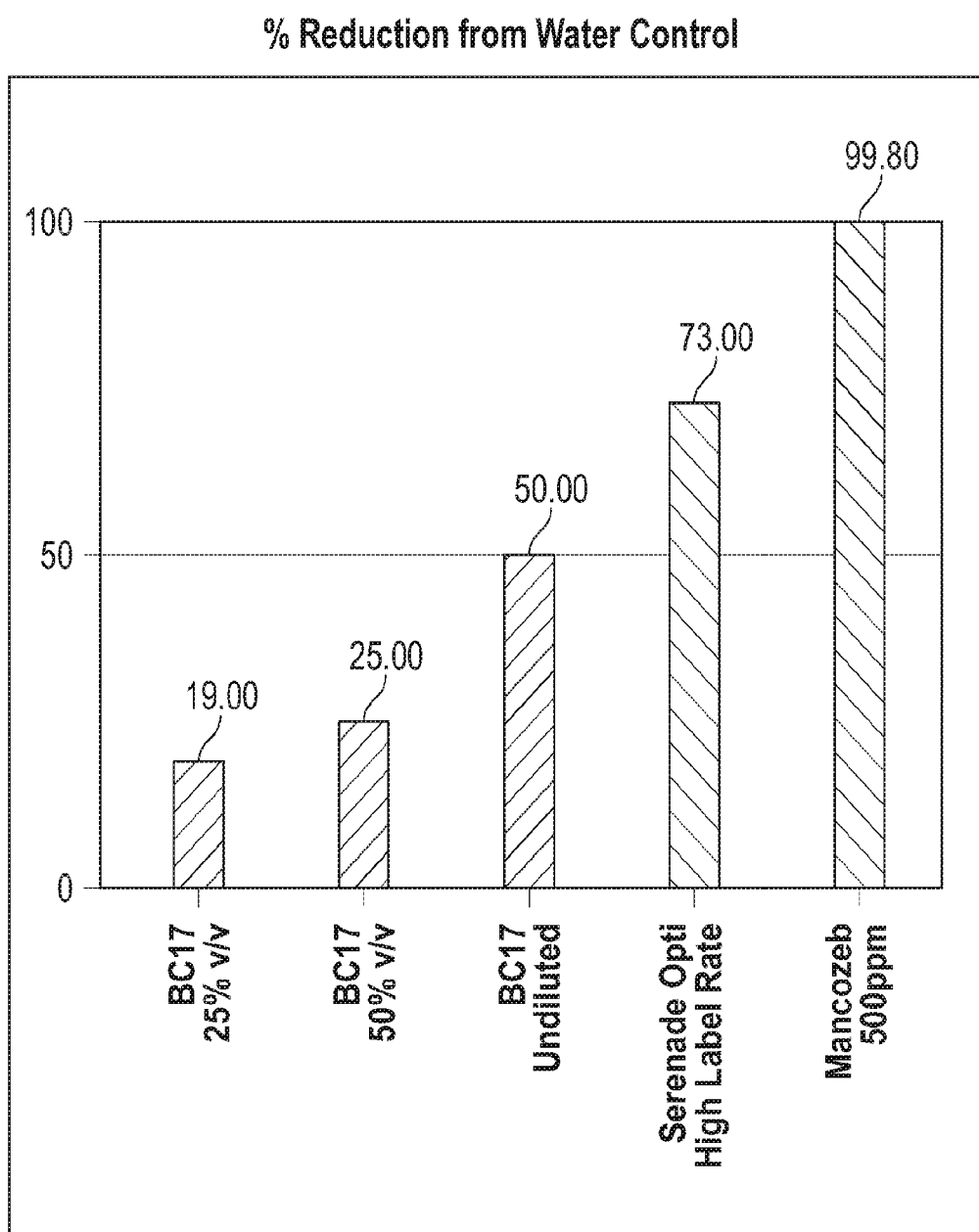
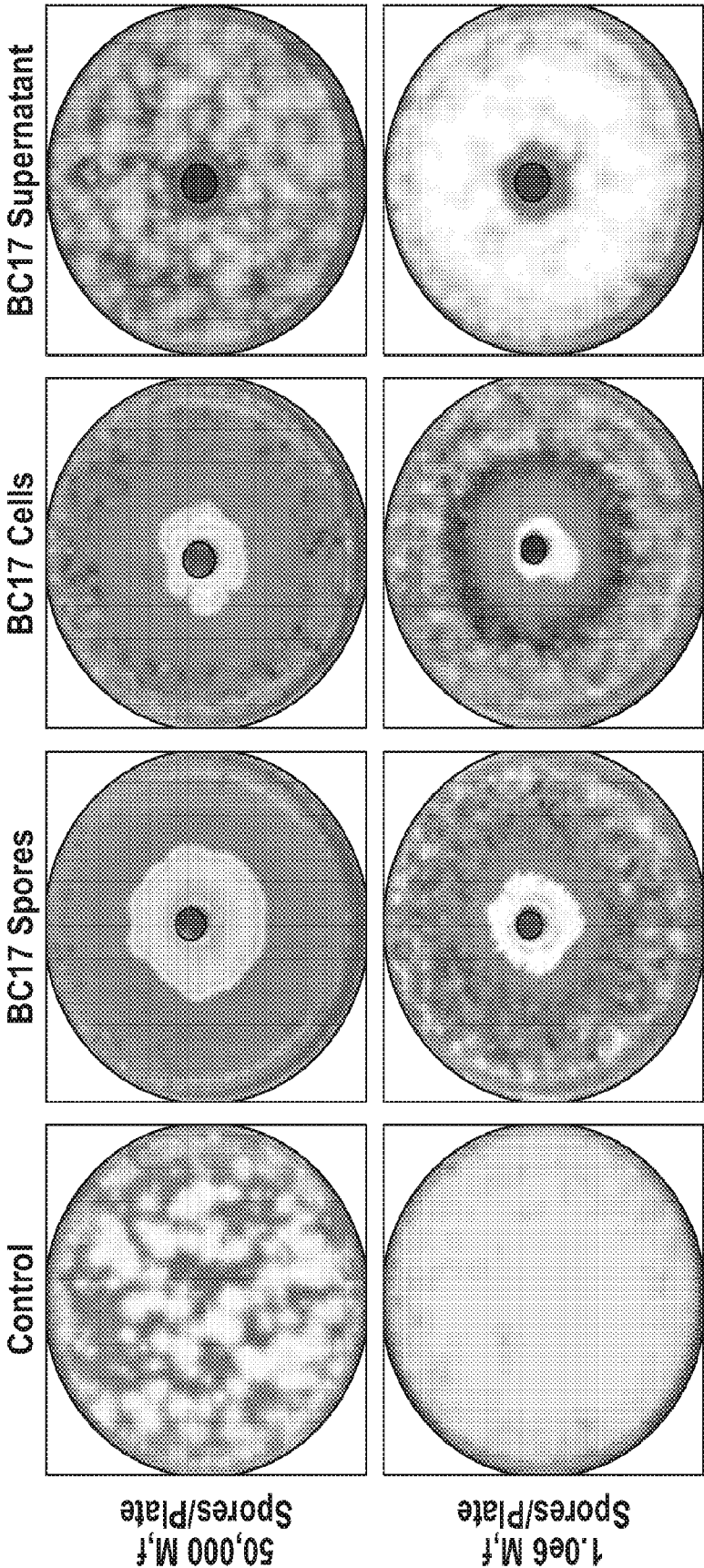
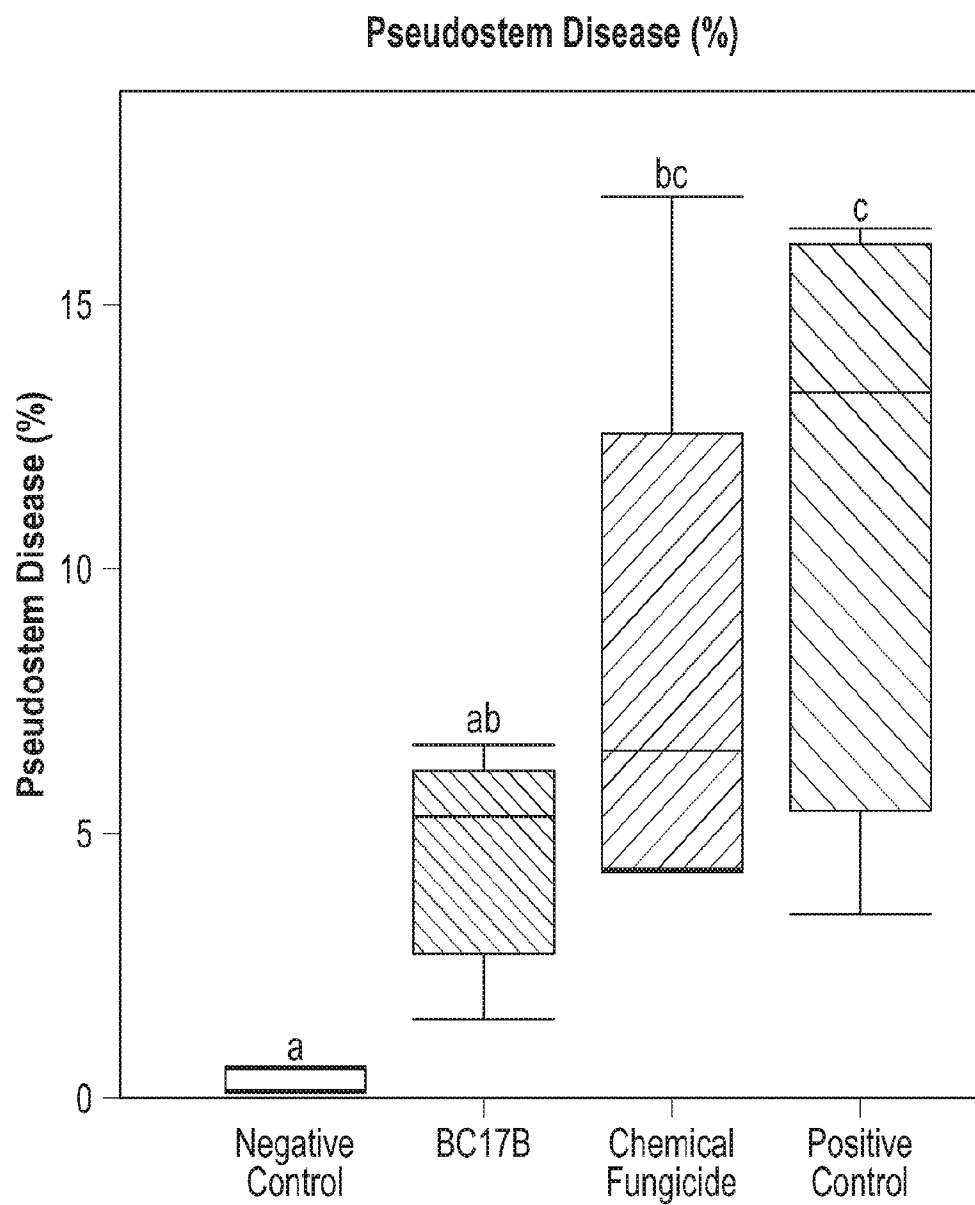


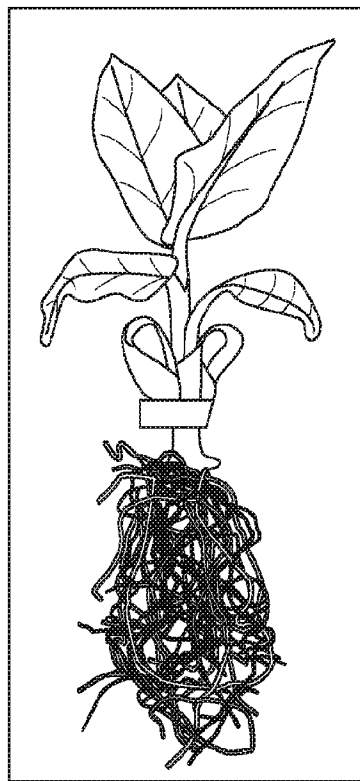
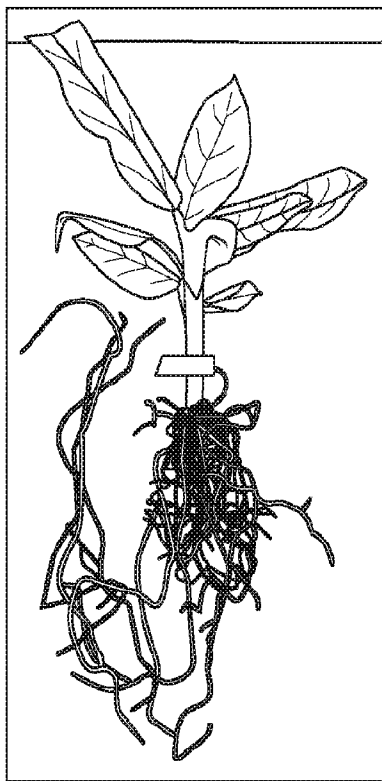
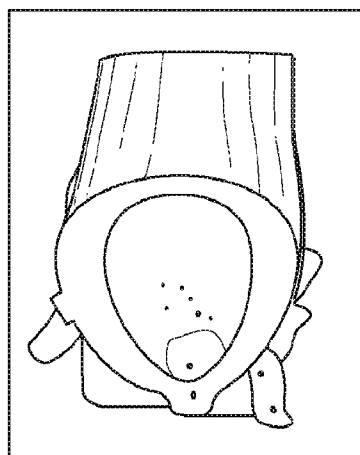
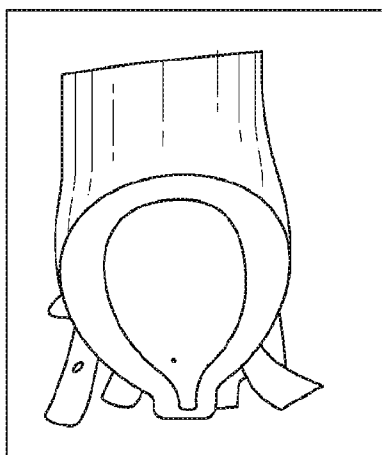
FIG. 11



M. Fructicola 3L-71 Strain Used in Assays. Photos Taken After 7 Days

FIG. 12

**FIG. 13A**

Plant Imaging**Whole Plants****Pseudostems**

BC17B

Positive Control

FIG. 13B

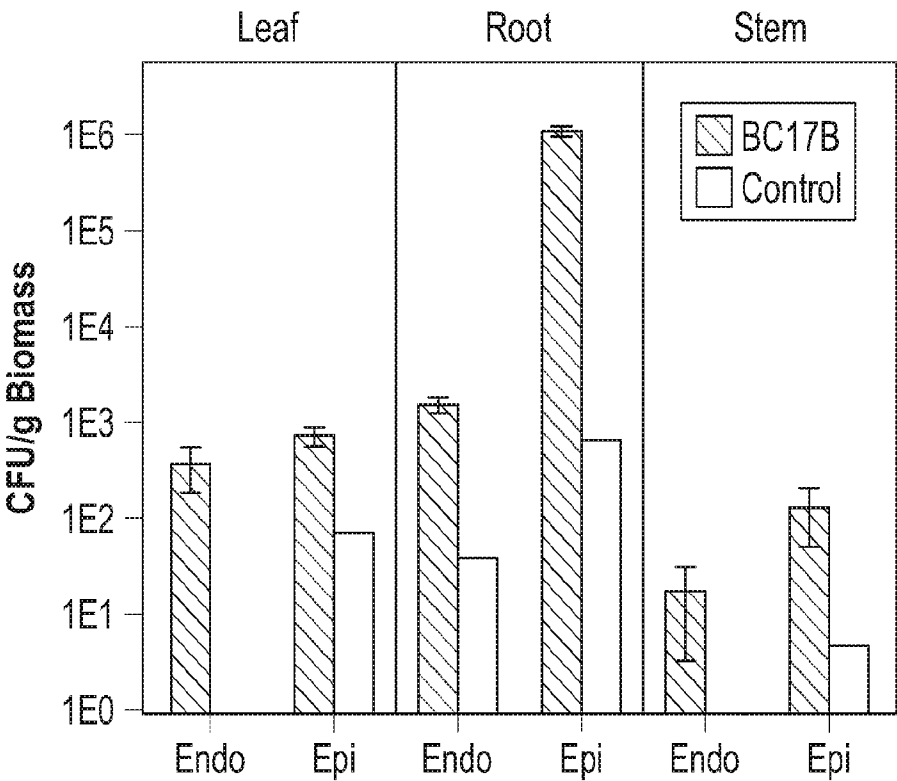
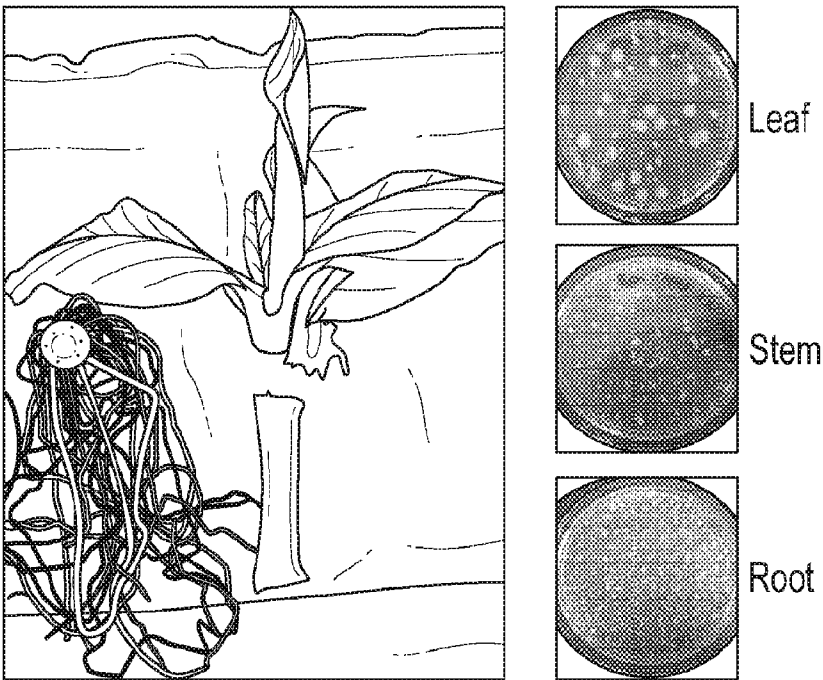


FIG. 14A



Root Systems Inoculated
with 10^9 CFU/mL BC17B

FIG. 14B

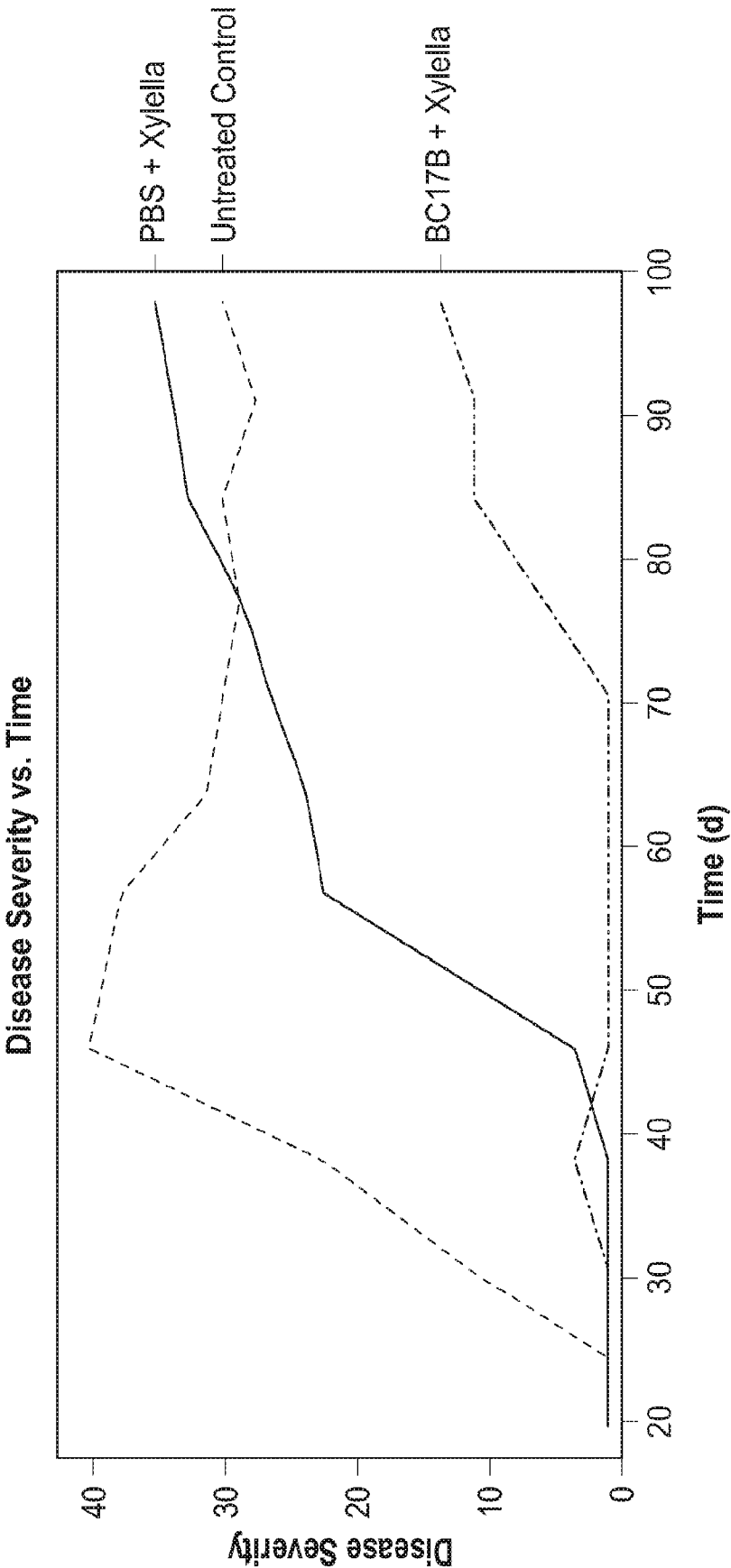


FIG. 15

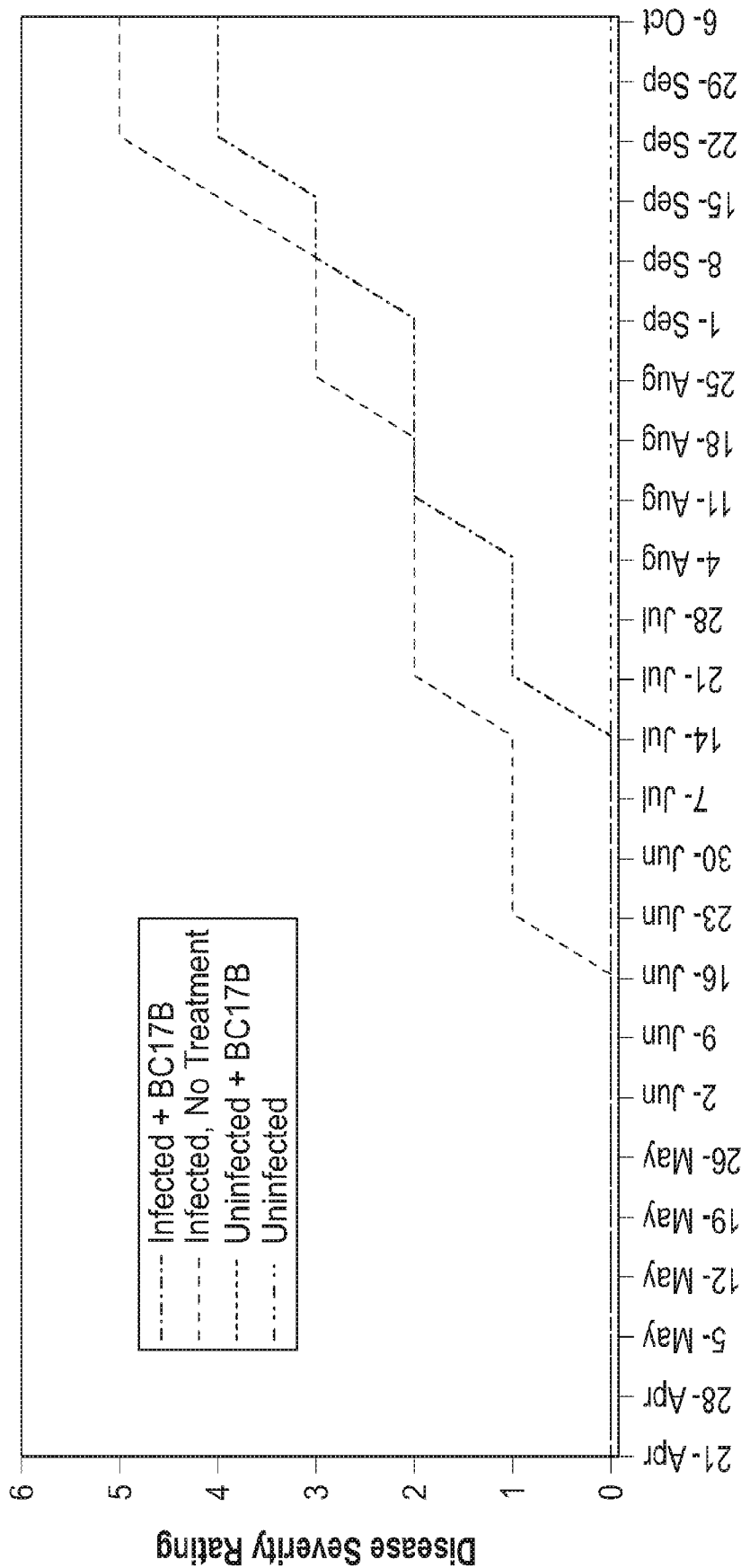


FIG. 16

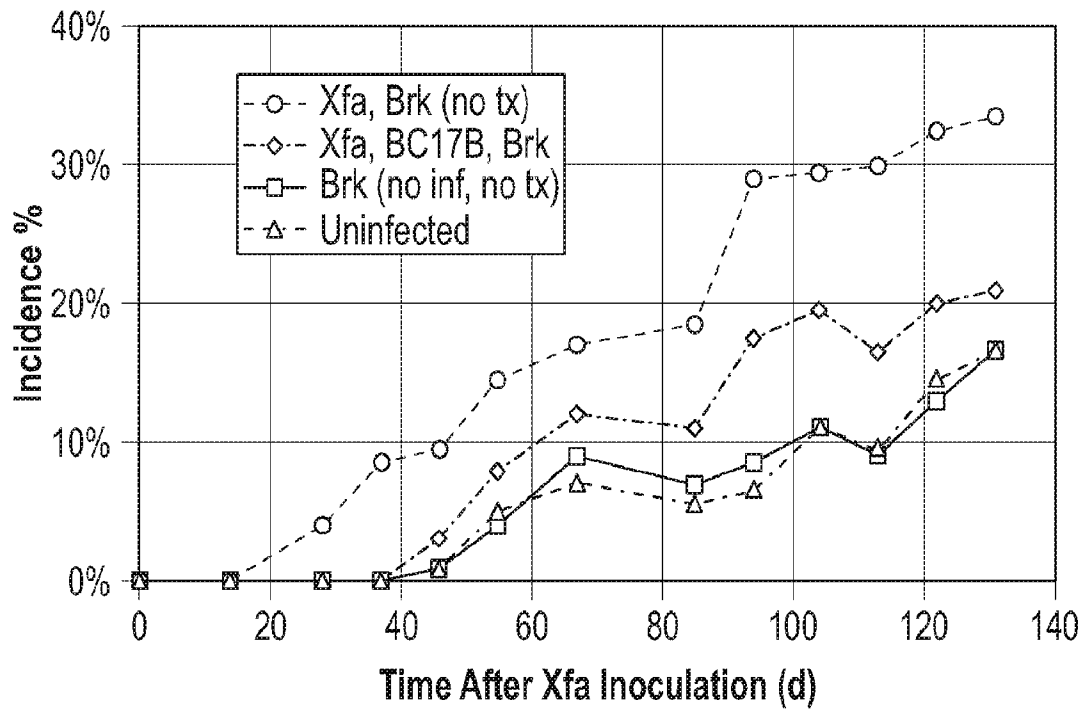


FIG. 17A

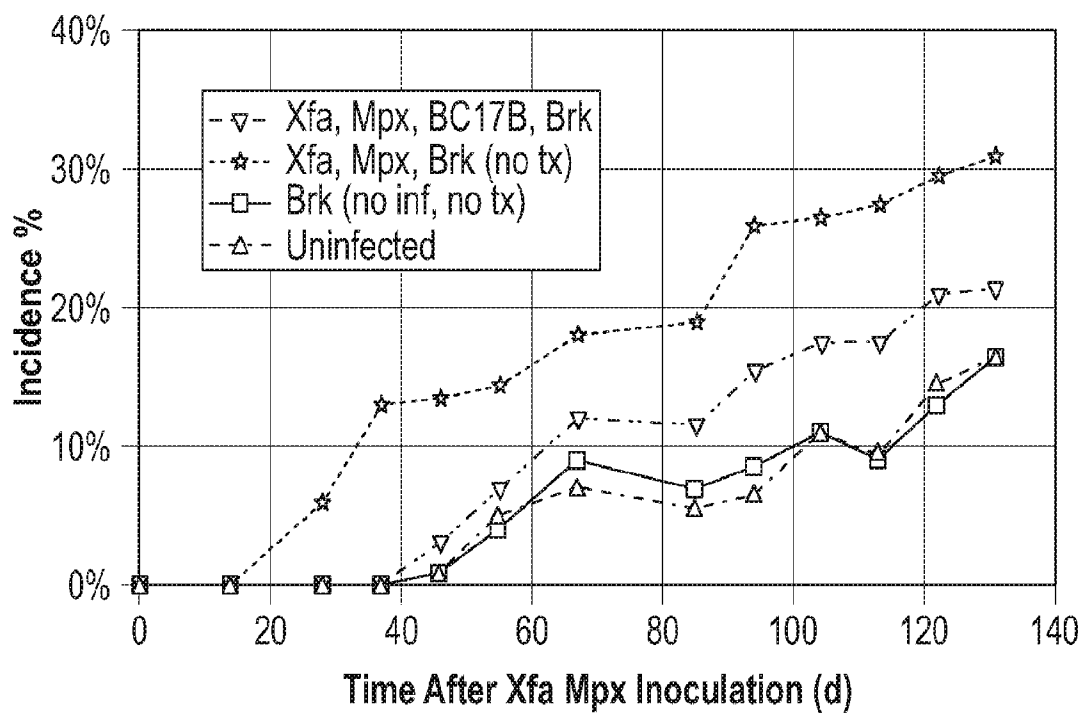


FIG. 17B

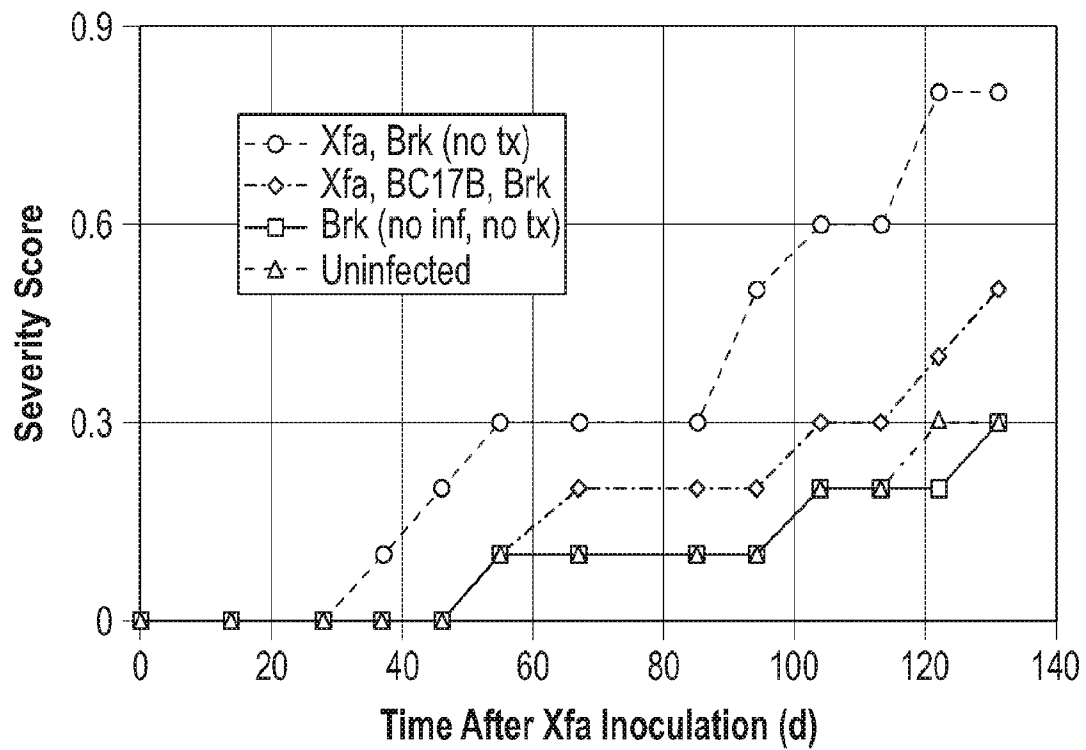


FIG. 17C

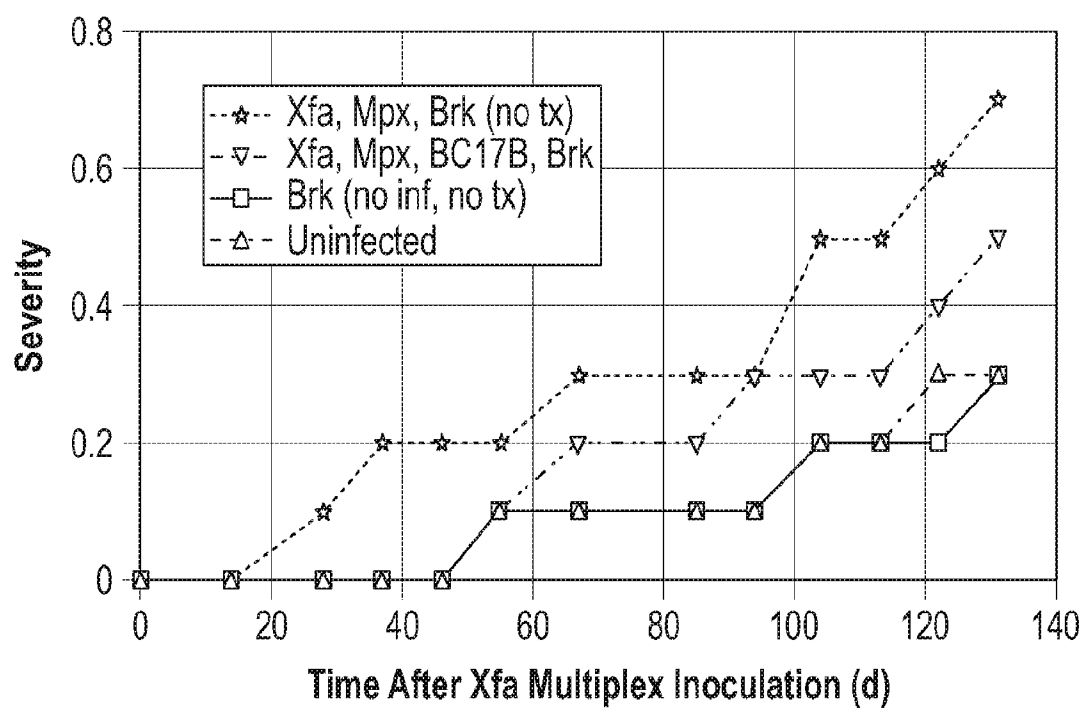


FIG. 17D

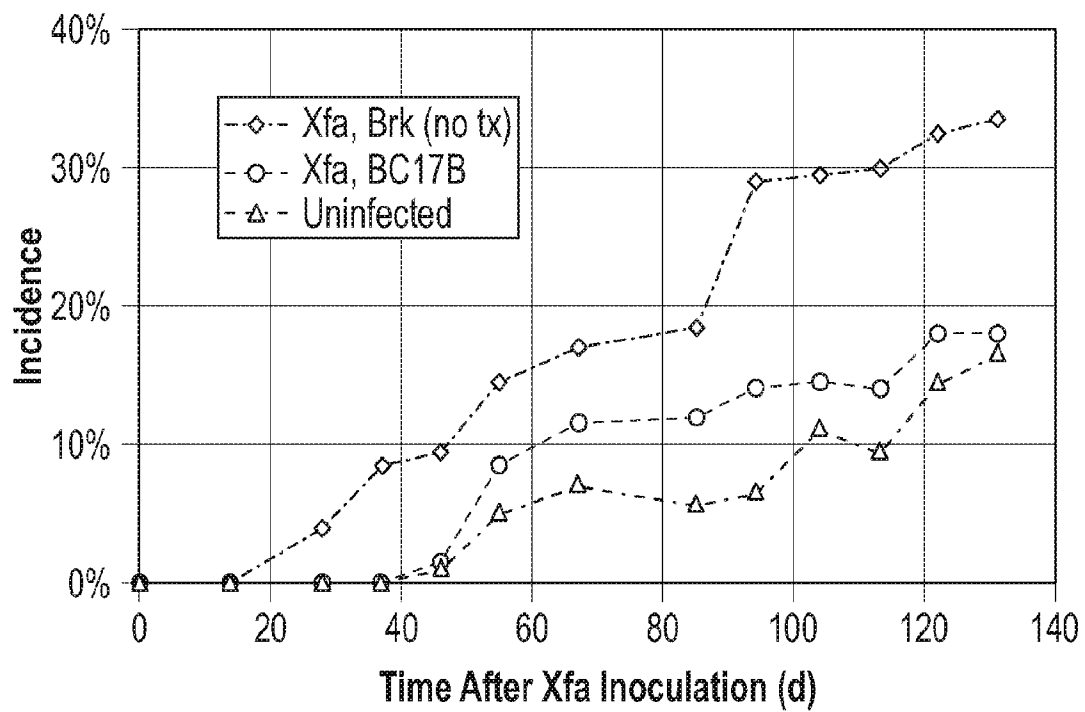


FIG. 17E

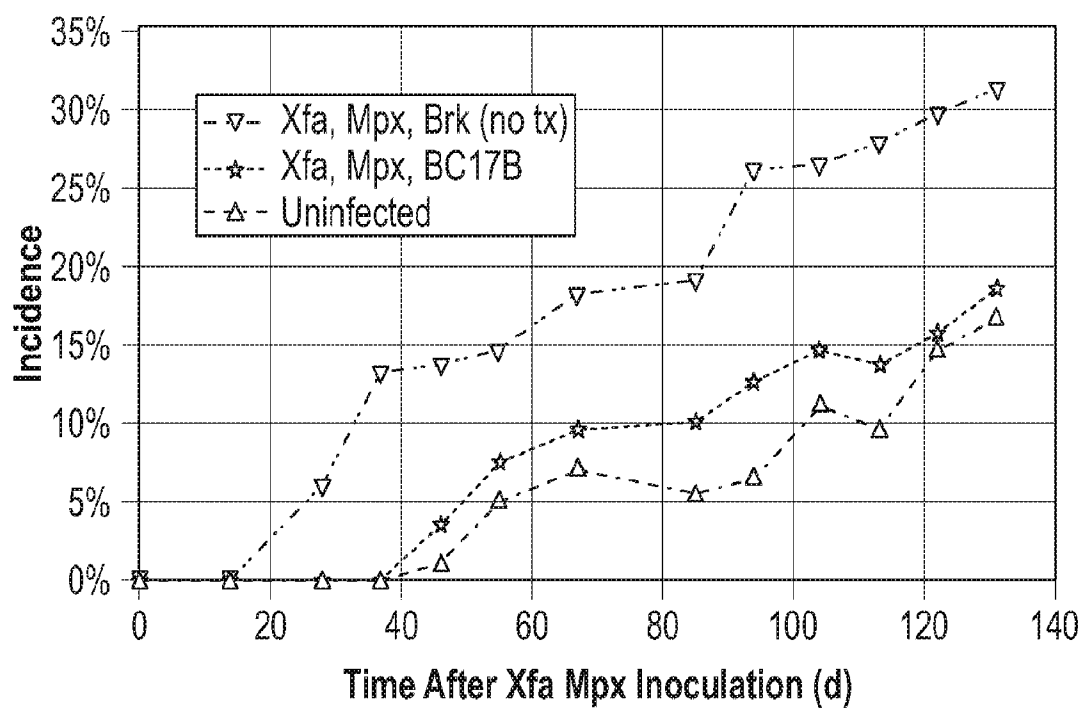


FIG. 17F

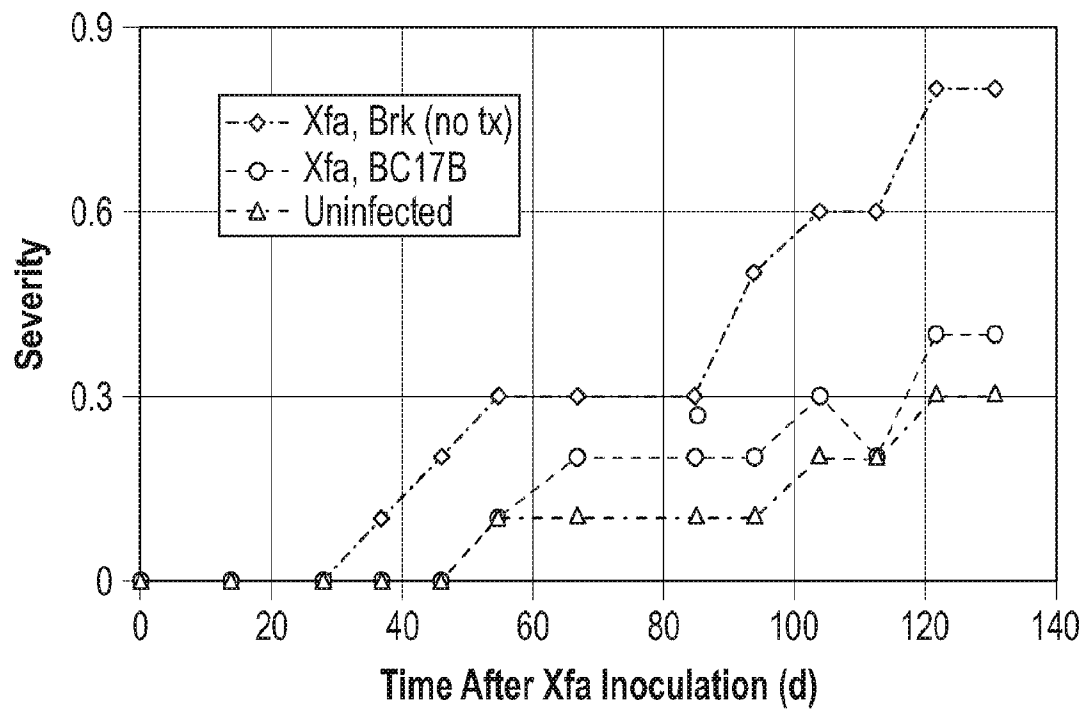


FIG. 17G

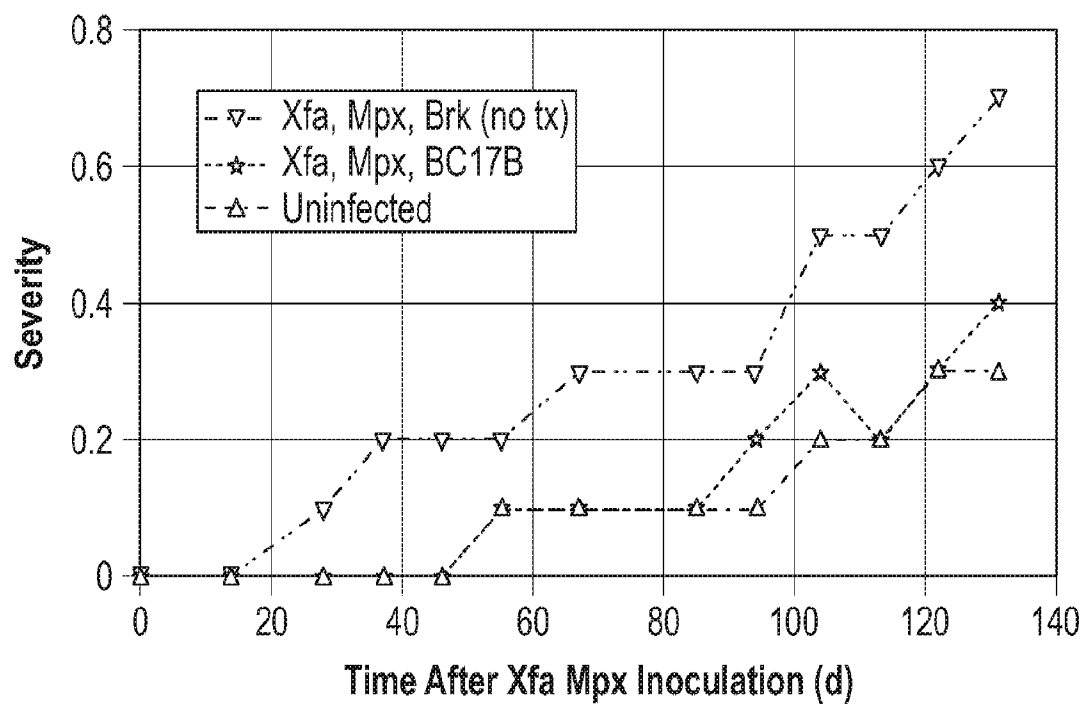


FIG. 17H

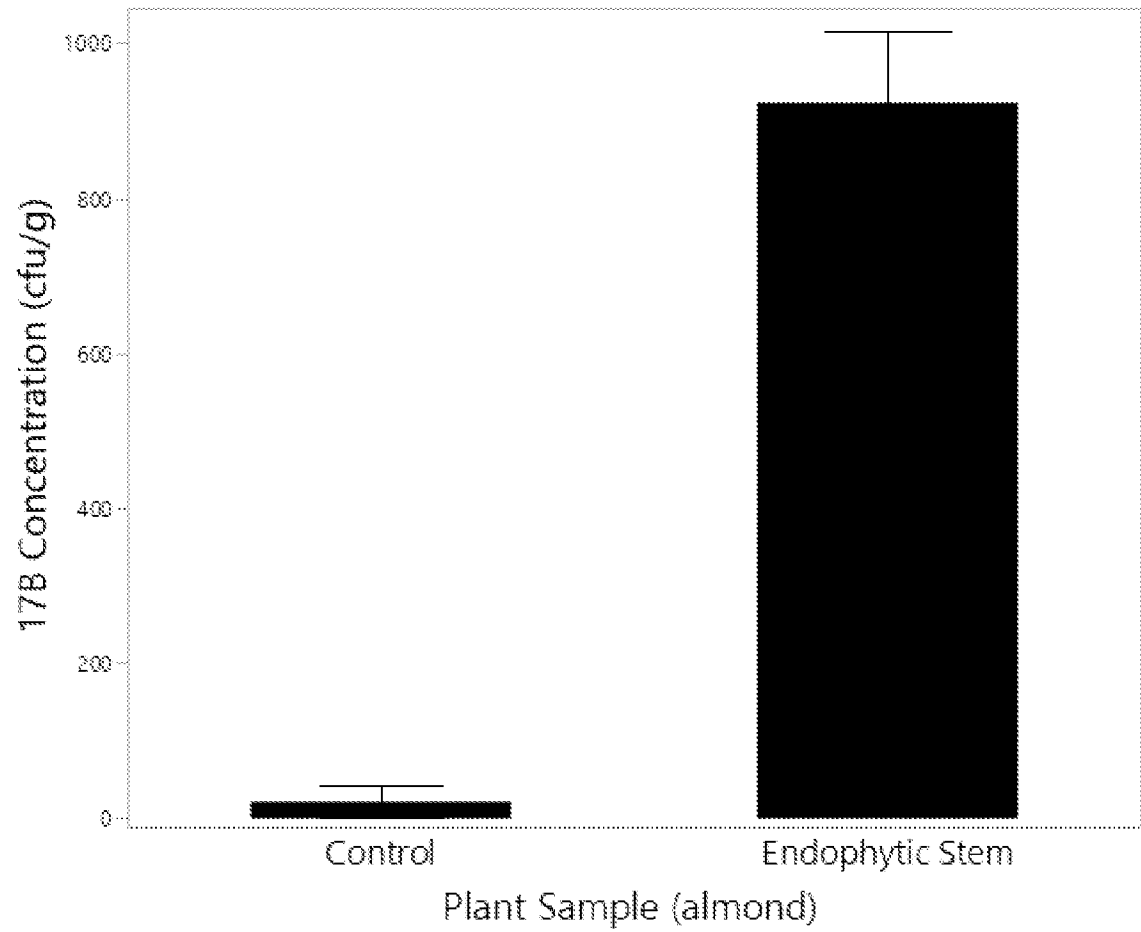
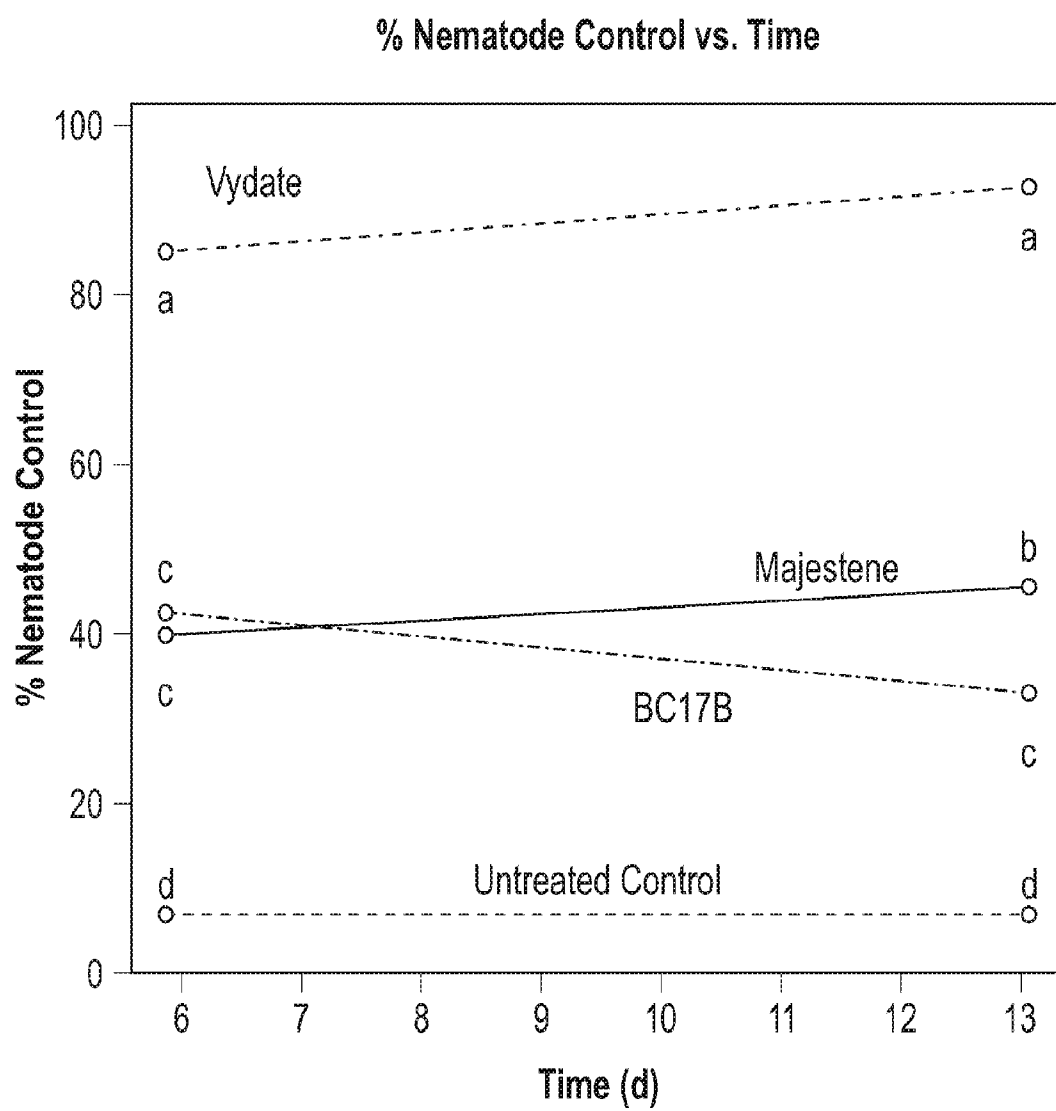


FIG. 18B



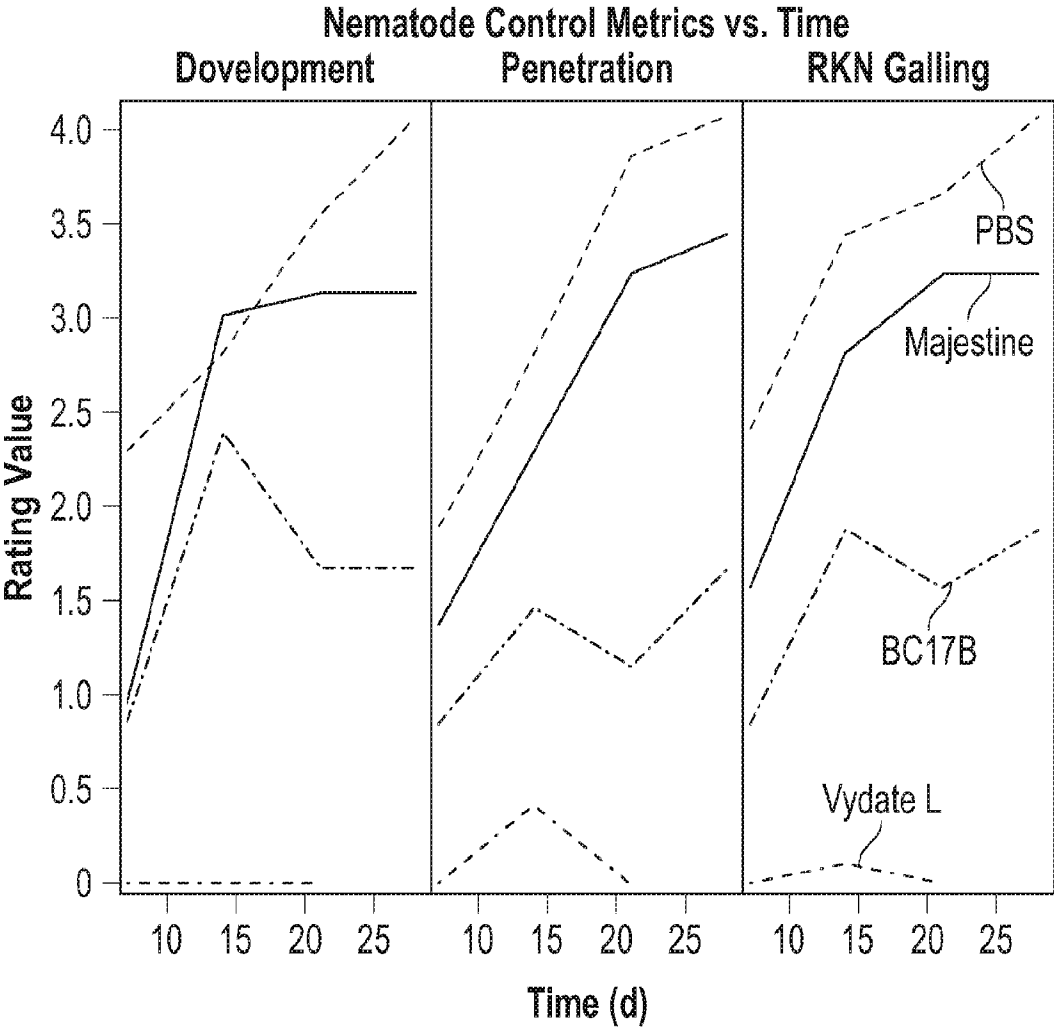
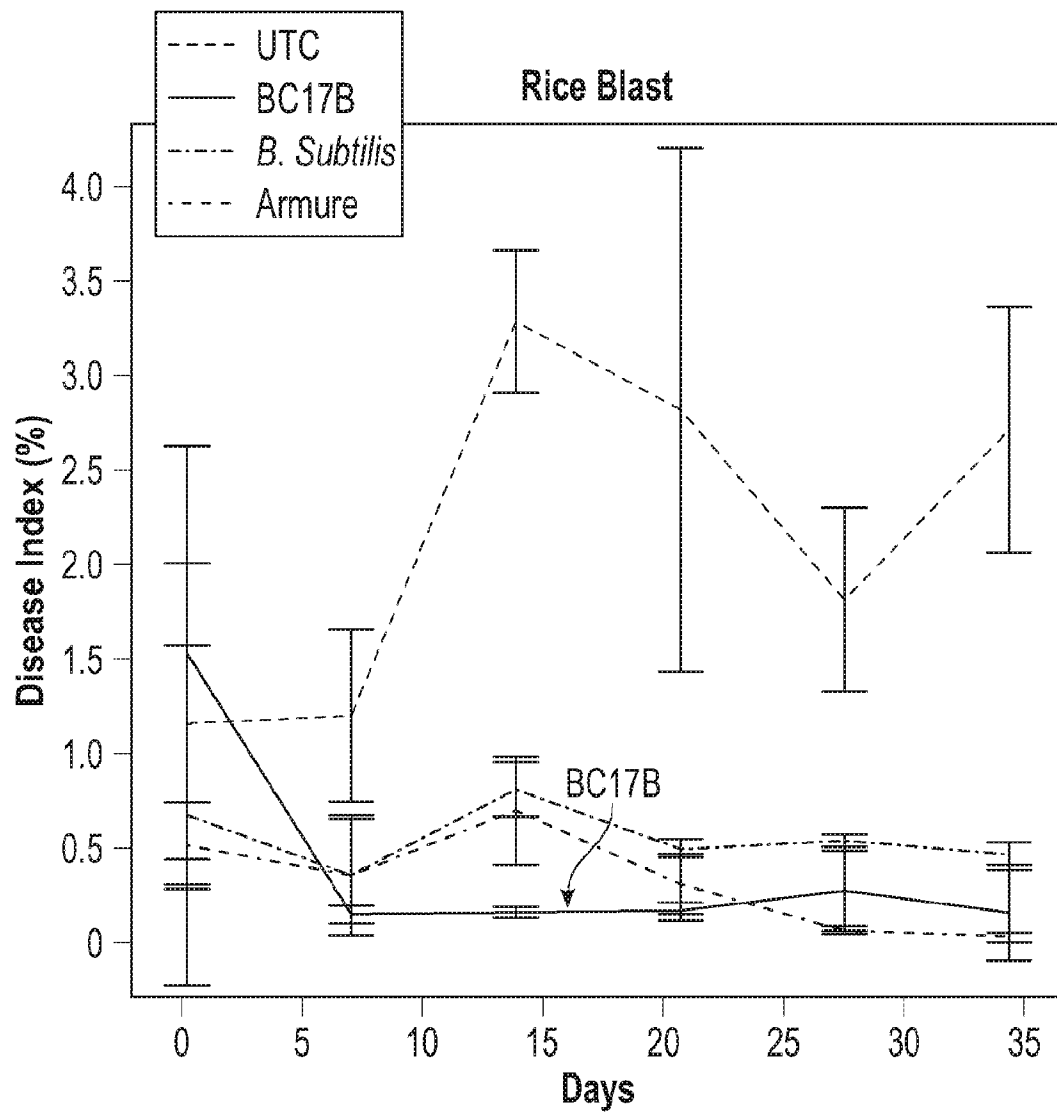


FIG. 20

**FIG. 21**

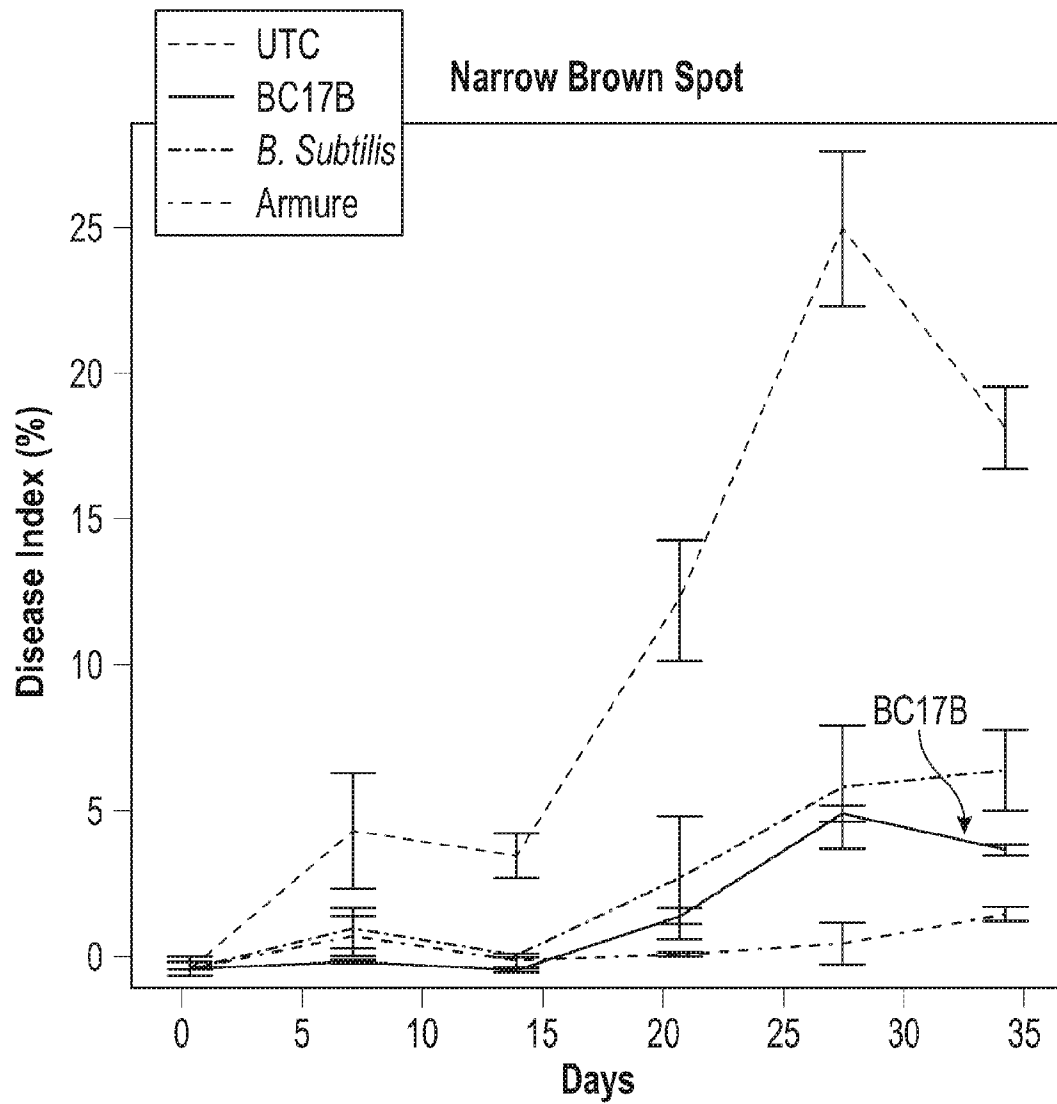
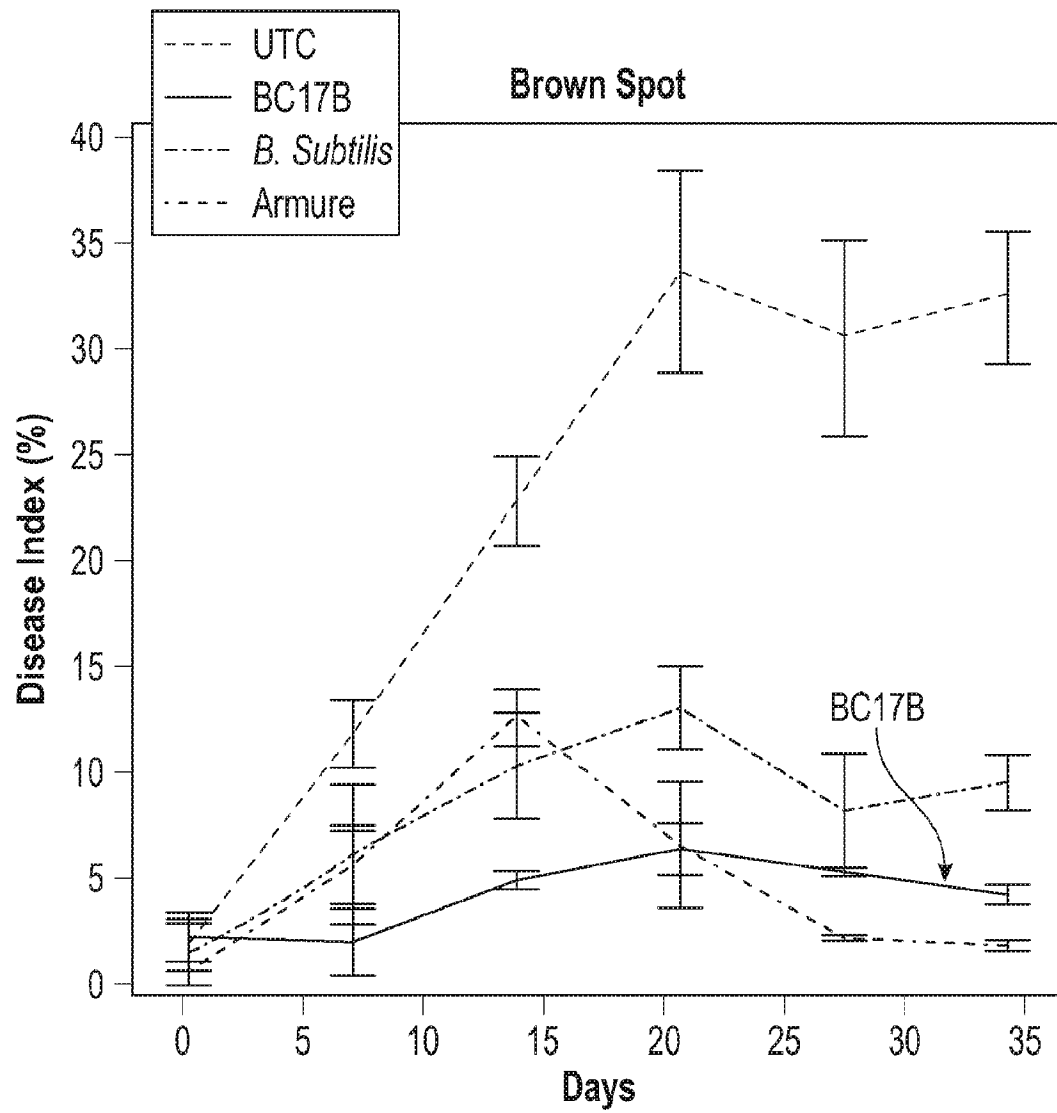
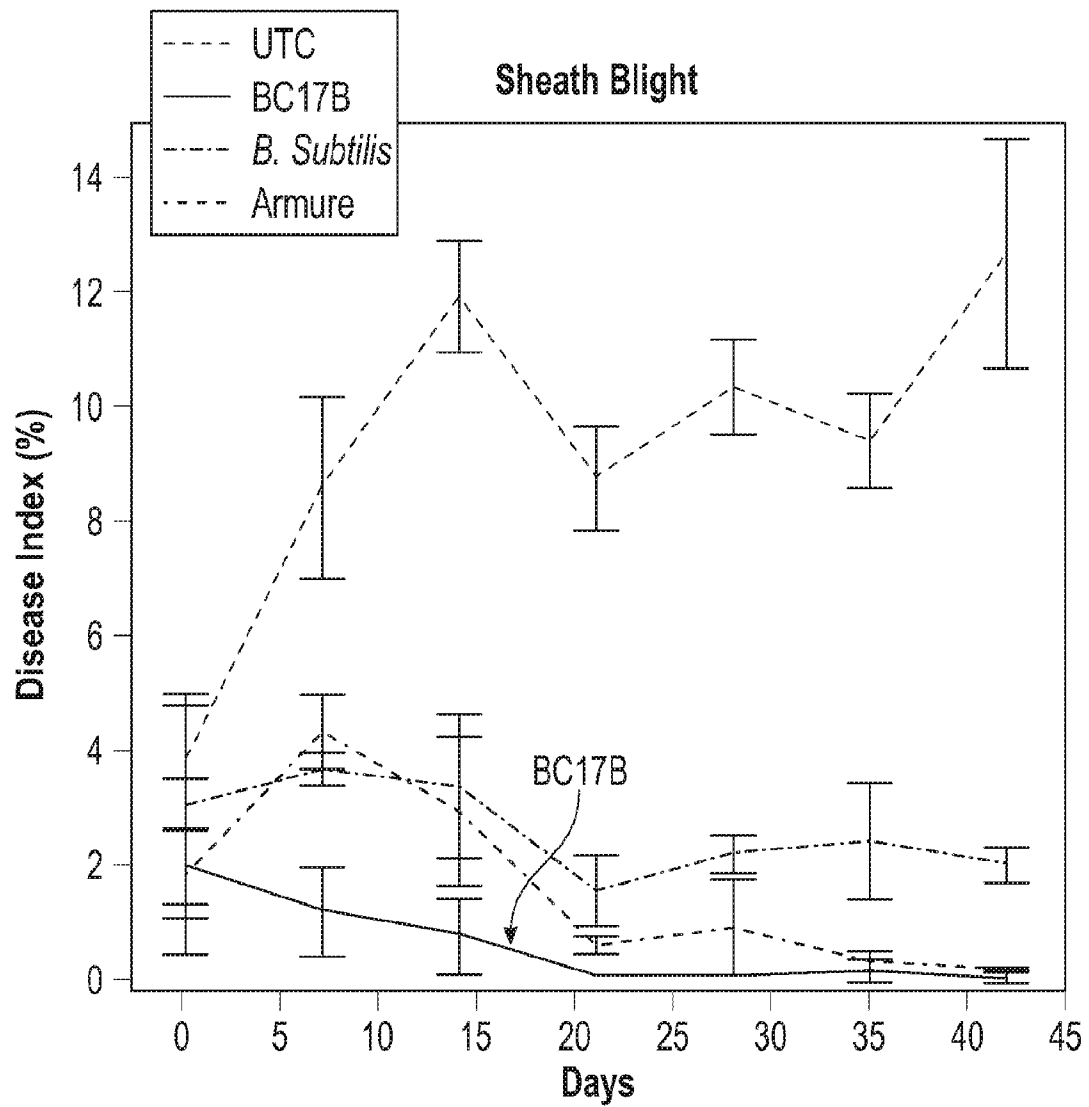
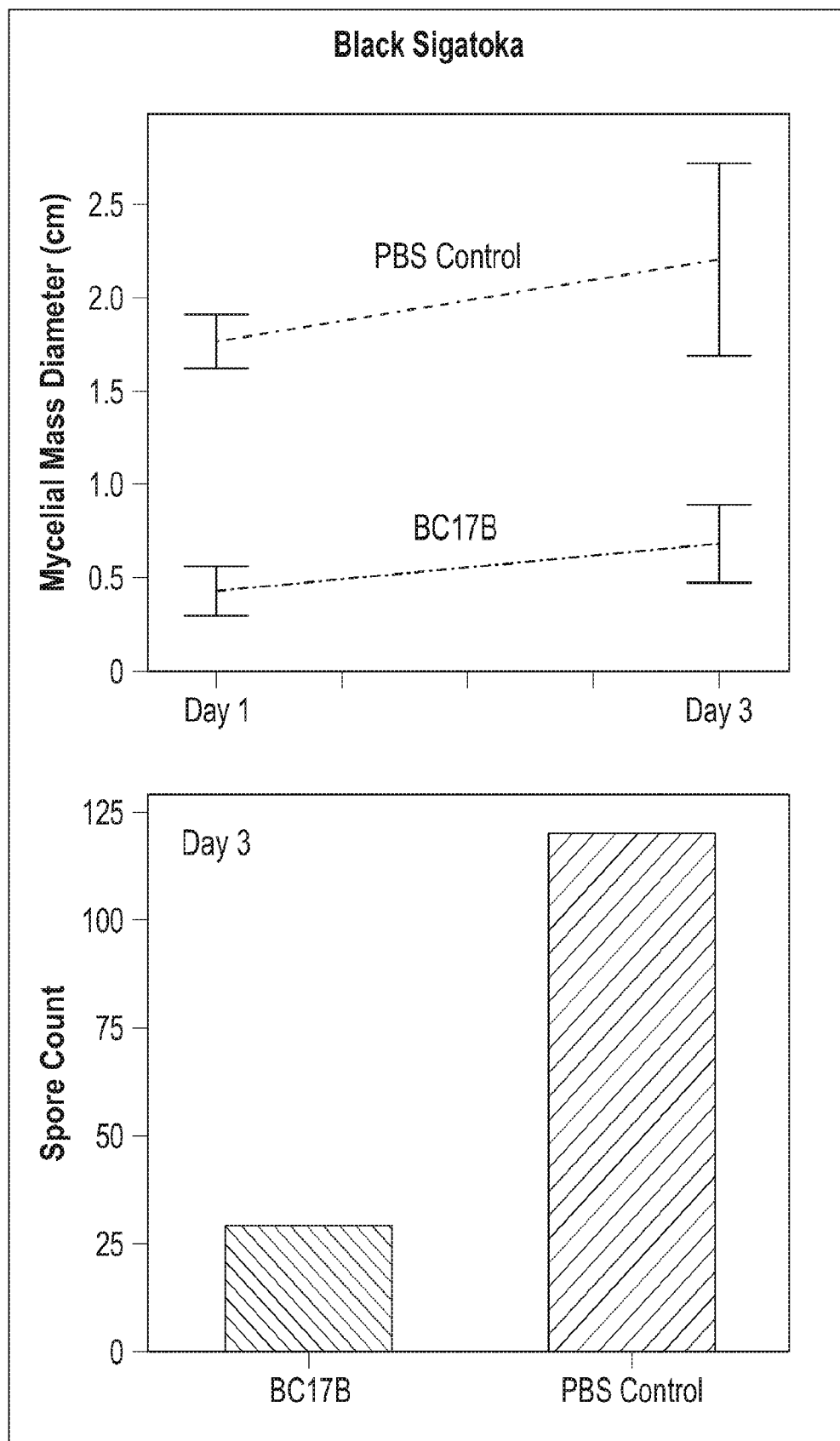


FIG. 22

**FIG. 23**

**FIG. 24**

**FIG. 25A**

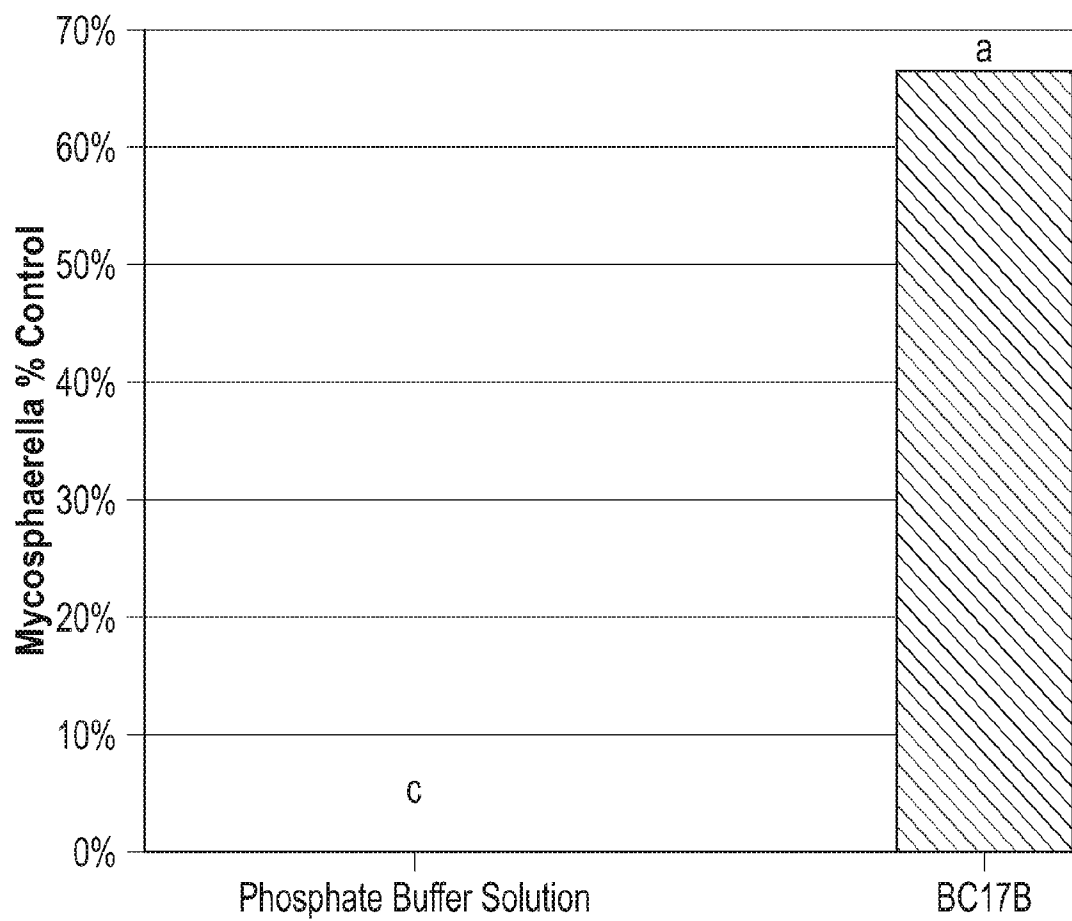


FIG. 25B

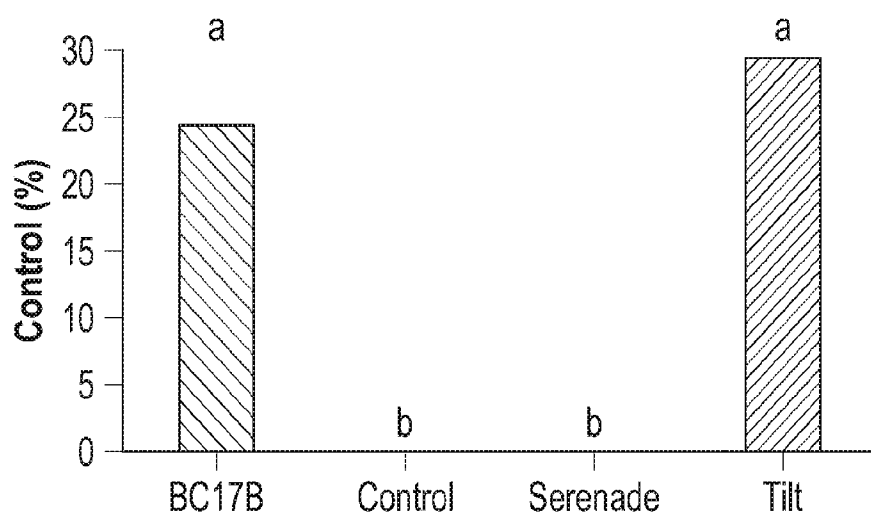


FIG. 26A

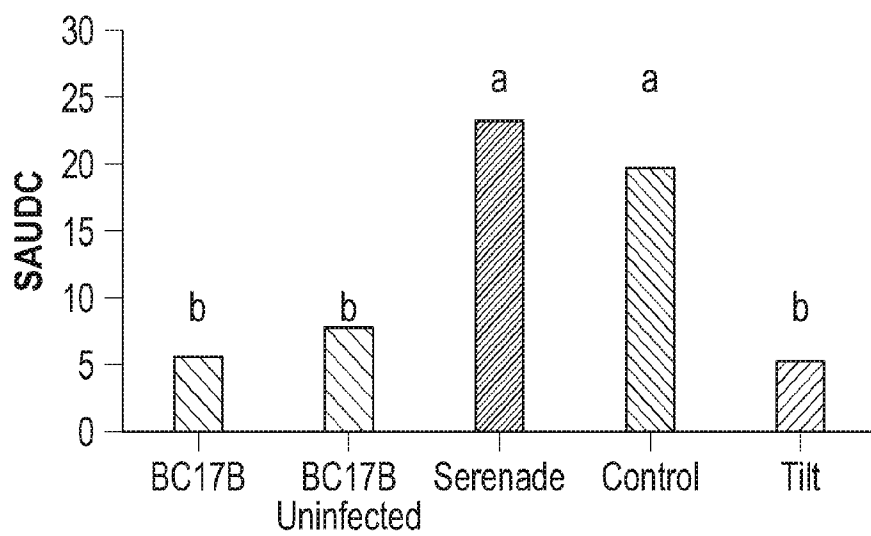


FIG. 26B

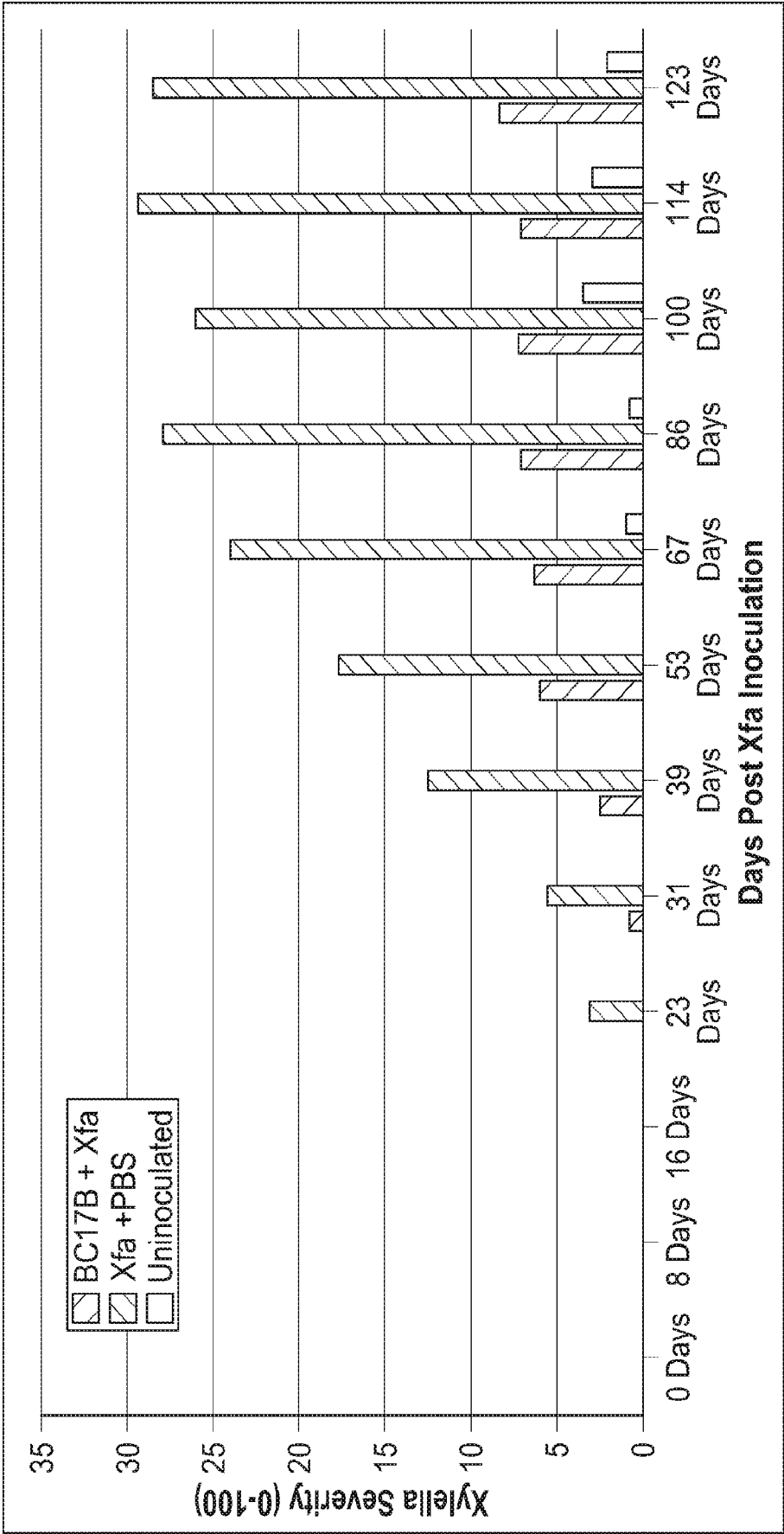


FIG. 27A

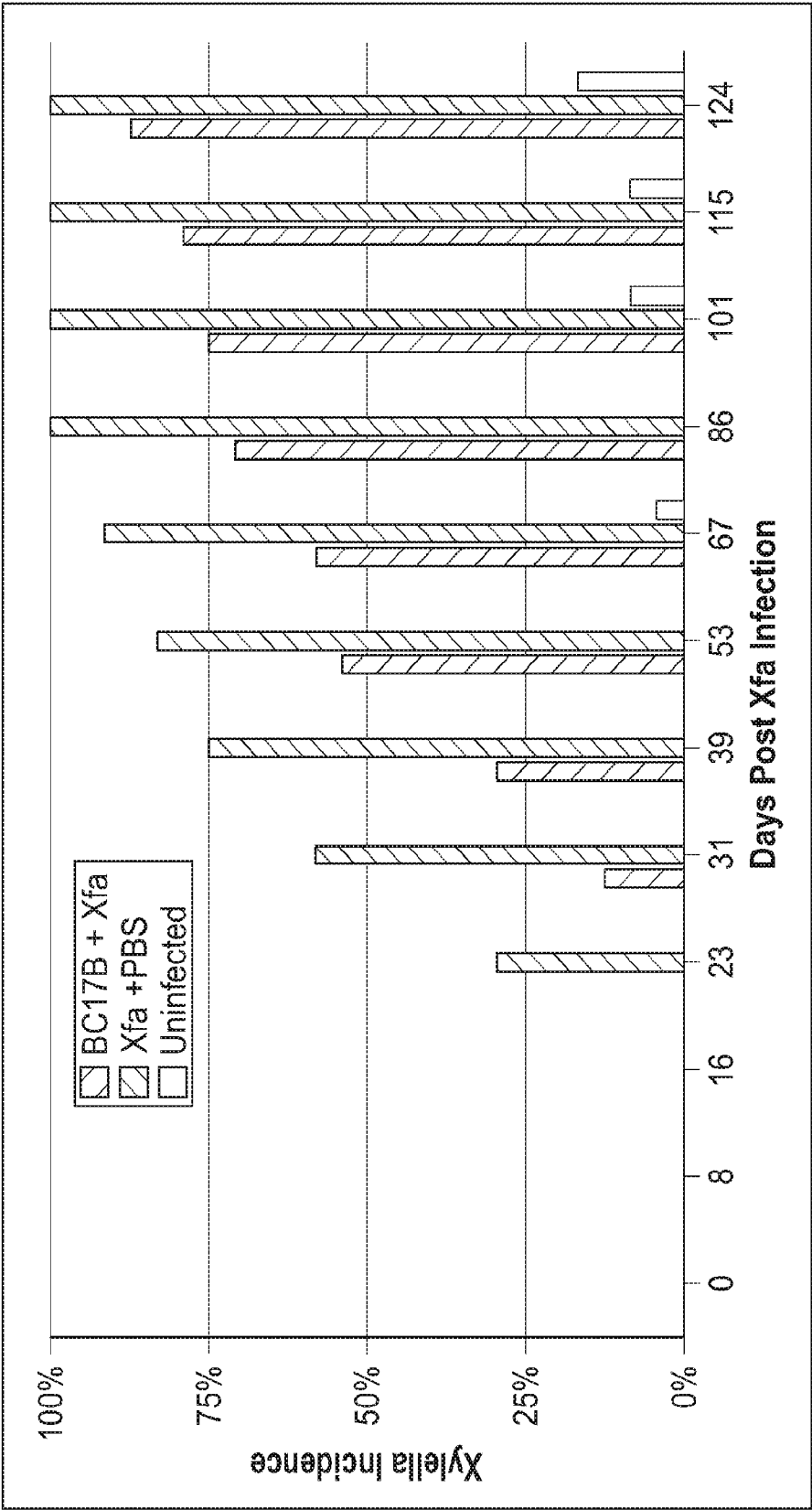
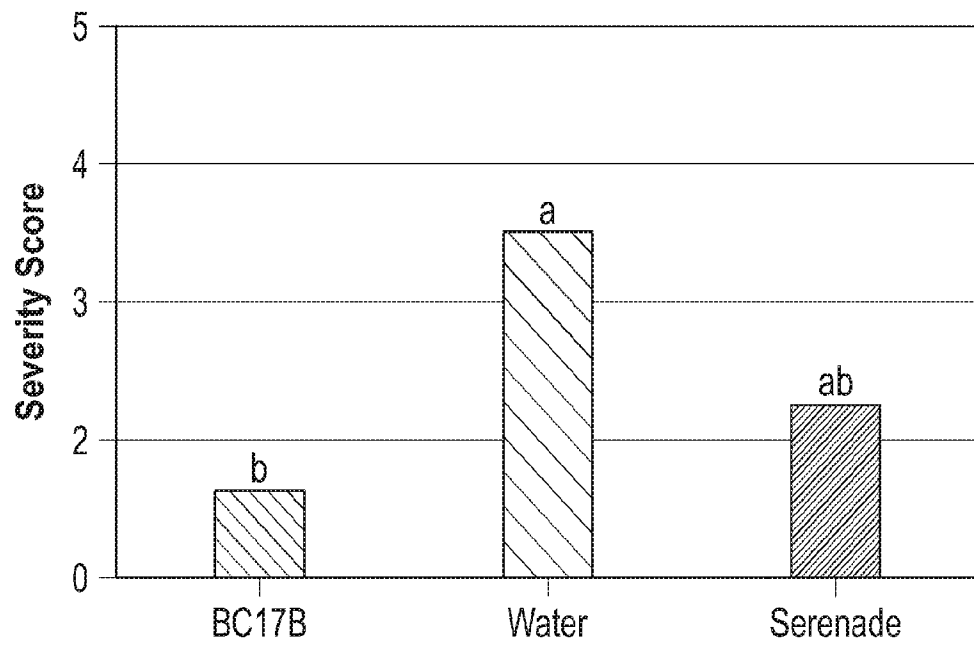
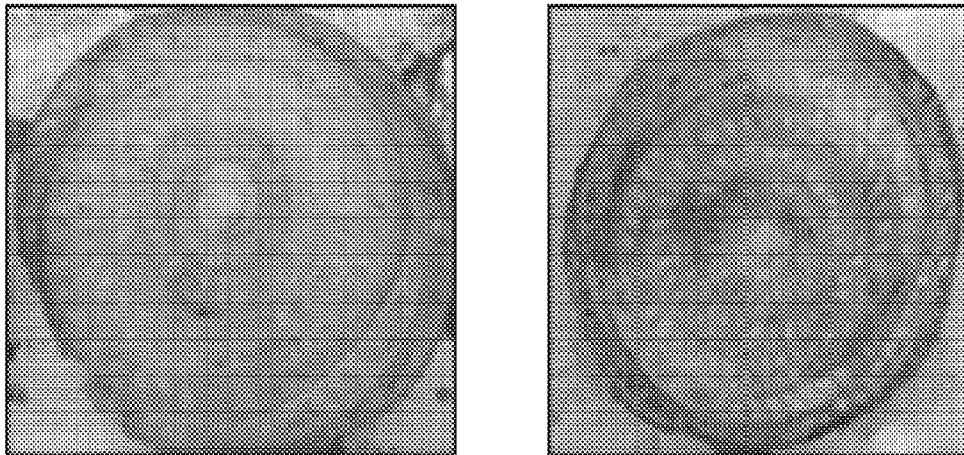


FIG. 27B

**FIG. 28A****FIG. 28B**

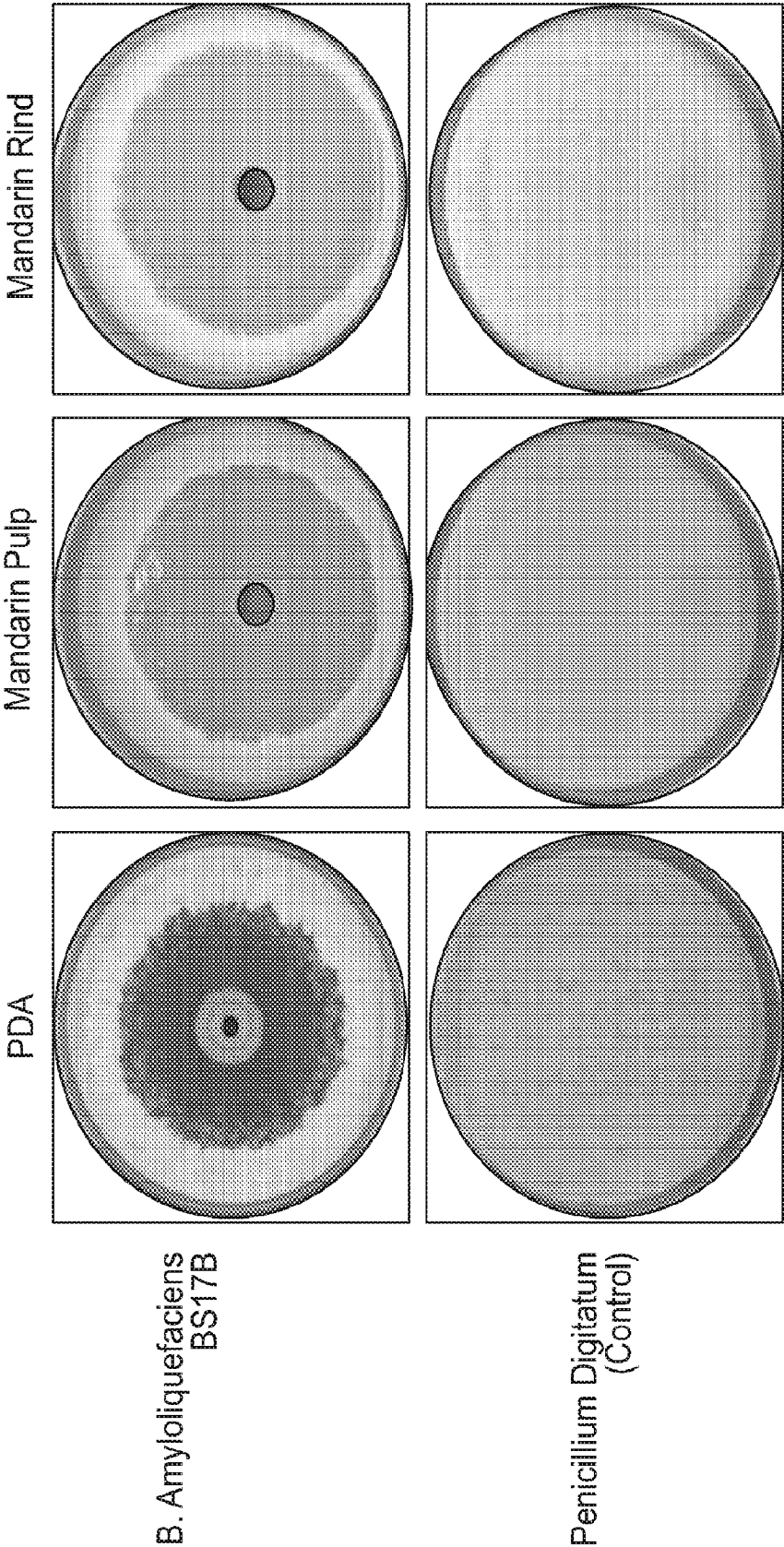
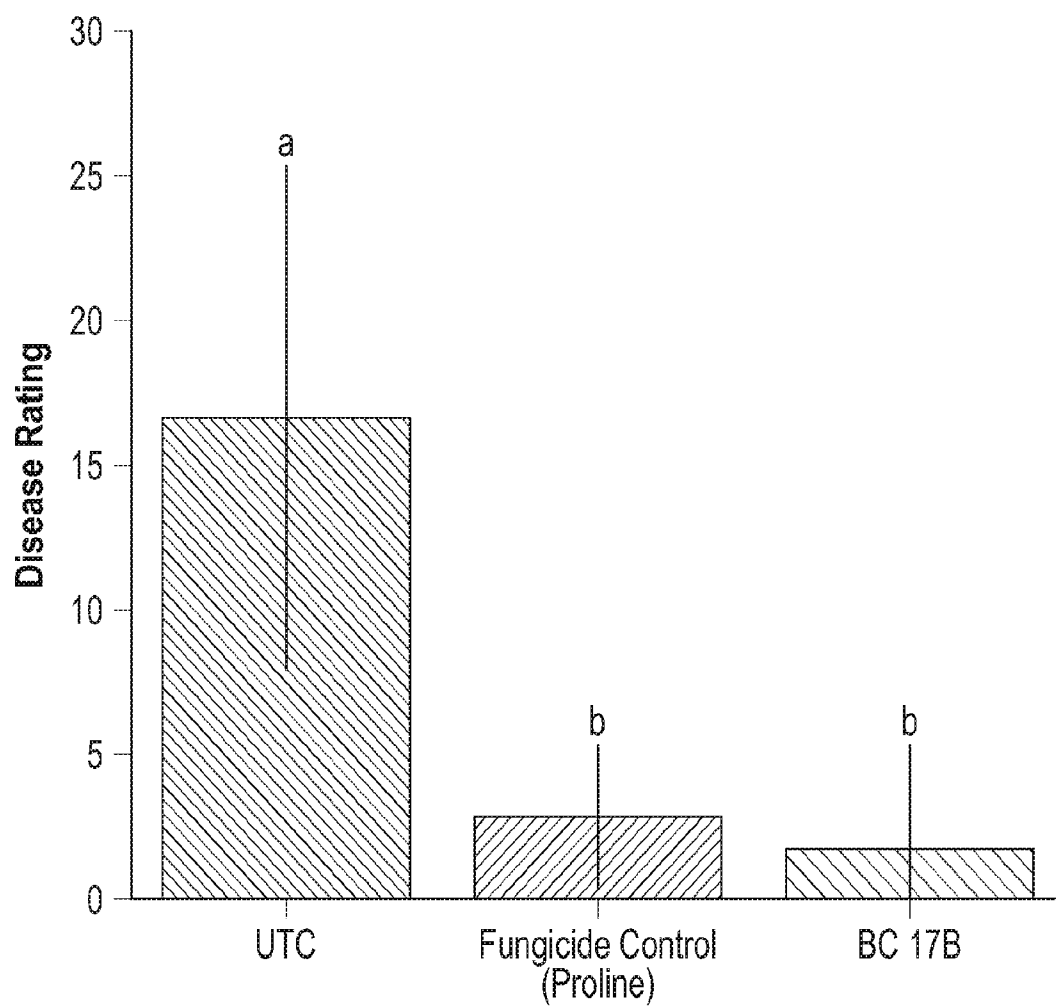
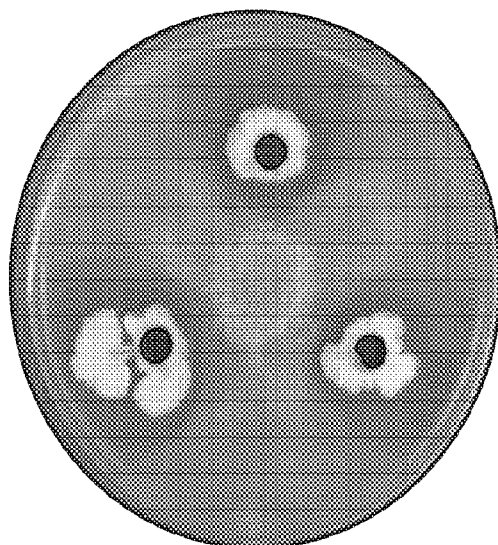
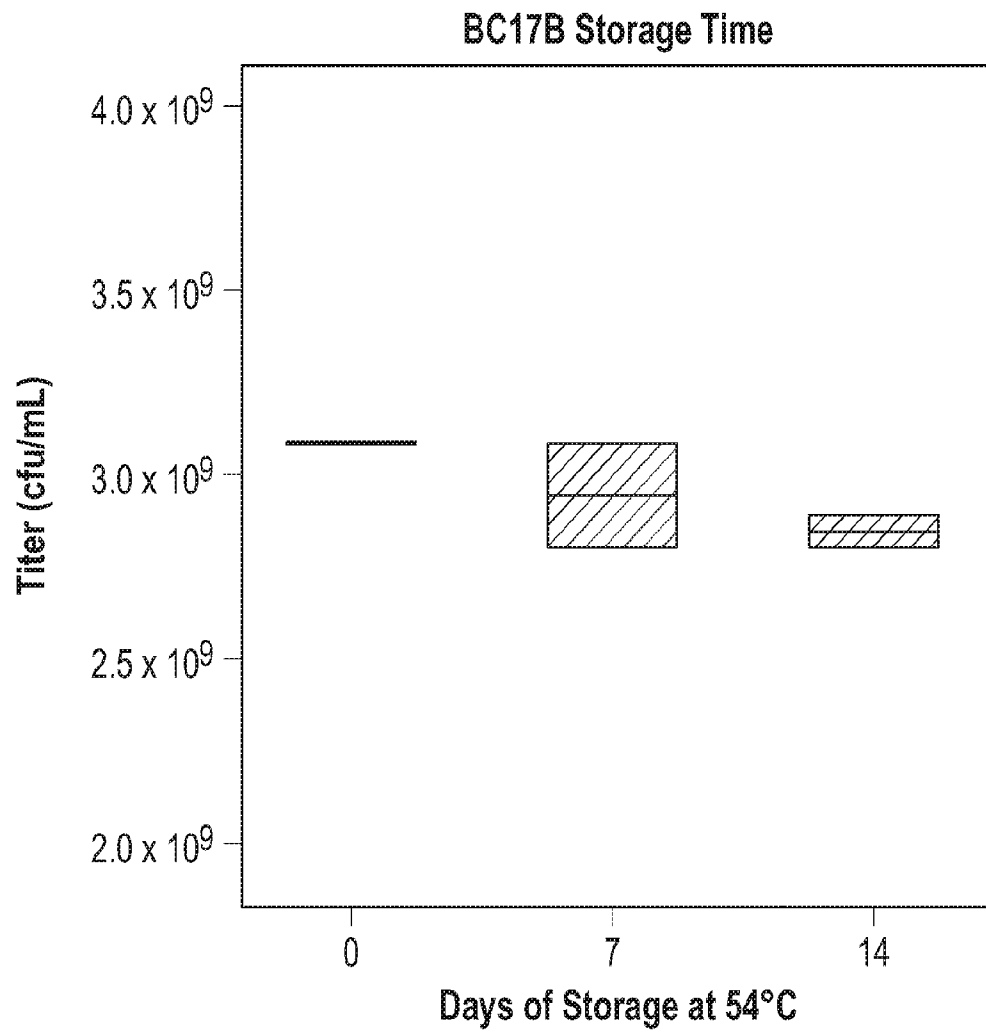


FIG. 29

**FIG. 30**



BC17B Observed to Control
Botrytis Cinerea after 14 Day
Storage at 54°C

FIG. 31B