stress tolerance, increase photosynthetic rate, and increase disease tolerance. Although the precise mechanism by which plant biostimulants exert their effect on plants, one hypothesis is that they operate by up-regulating or down-regulating plant hormones.

Despite advances in agricultural compositions and methods, there remains a need for compositions and methods that can perform plant biostimulation, i.e., improving plant growth responses and development, while reducing the use of chemical fertilizers. Methods and compositions disclosed herein may address these needs and others.

SUMMARY

In accordance with the disclosure herein, as embodied and broadly described herein, the disclosurerelates to compositions and methods for plant biostimulation. Also disclosed herein are compositions comprising a cell-free supernatant of a microbial culture comprising a mixture of microorganisms, which may comprise one or more of bacteria, fungi, algae, and/or microorganisms. Methods of the present disclosure comprise using compositions disclosed herein to enhance the growth of plants.

In a first aspect of the present disclosure, there is provided a composition comprising:

(i) an isolated cell-free supernatant of a microbial culture obtained by (1) inoculating an isolated mixed microbial composition comprising isolated microorganisms of either IN-MI, ATCC Patent Deposit Designation No. PTA-12383 into a culture media comprising water, molasses, mineral powder, sea salt, and wheat bran, (2) incubating the inoculated media for 3-10 weeks at 30-32 or 35-37 or 32-37 degrees Celsius, thereby obtaining the microbial culture, and (3) centrifuging the microbial culture to separate microbial culture cells from a supernatant and filter sterilizing the supernatant to obtain the cell-free supernatant of the microbial culture, wherein the cell free supernatant comprises high levels of potassium, nitrogen, calcium, and magnesium, and significant levels of volatile fatty acids, and

(ii) diluent water,

wherein the ratio between the cell-free supernatant of the microbial culture and the diluent water in the cell-free supernatant composition is between 1:25 and 1:1000.

In a second aspect of the present disclosure, there is provided a composition comprising an agronomically acceptable carrier and an effective amount of the cell-free supernatant composition of the first aspect.

In a third aspect of the present disclosure, there is provided a method of enhancing plant growth comprising providing a cell-free supernatant composition of the first aspect or a composition of the second aspect to a seed, to a plant, or to a plant at a particular growth stage, or combinations thereof, thereby enhancing plant growth, wherein the plant is a crop plant.

Disclosed are compositions comprising a cell-free supernatant of a microbial culture inoculated with an isolated microorganism, wherein the microorganism comprises one or more of *Aspergillus* spp., *Bacillus* spp., *Rhodopseudomonas* spp., *Candida* spp., *Lactobacillus* spp., *Lactococcus* spp., *Pseudomonas* spp., *Saccharomyces* spp., or *Streptococcus* spp.; or combinations thereof.

Also disclosed are methods of enhancing plant growth comprising providing the disclosed cell-free supernatant composition to a seed, to a plant, or to a plant at a particular growth stage, or combinations thereof, thereby enhancing plant growth. Growth is enhanced when a plant treated with a composition disclosed herein has

palustris. A disclosed cell-free supernatant composition from a microbial culture wherein the *Rhodopseudomonas* spp. is *Rhodopseudomonas* palustris, IN-RPl, ATCC Patent Deposit Designation No. PTA-12383. A disclosed cell-free supernatant composition from a microbial culture wherein the *Rhodopseudomonas* spp. is *Rhodopseudomonas* palustris, IN-RP2, deposited with the ATCC Patent Depository under the Budapest Treaty, on September 4, 2014, with the designation TN-RP2, under Account No. 200139, with the ATCC Patent Deposit Designation No. PTA-121553. A disclosed cell-free supernatant composition from a microbial culture wherein the *Saccharomyces* spp. is *Saccharomyces cerevisiae*. A disclosed cell-free supernatant composition from a microbial culture wherein the *Saccharomyces* spp. is *Saccharomyces cerevisiae*, IN-SCl, ATCC Patent Deposit Designation No. PTA-12384. A disclosed cell-free supernatant composition from a microbial culture wherein the *Streptococcus* spp. is *Streptococcus lactis*. A disclosed cell-free supernatant composition from a microbial culture further comprising at least one isolated mycorrhizal fungus. A disclosed cell-free supernatant composition from a microbial culture wherein the microbial culture is inoculated with of at least two of *Aspergillus* spp., *Bacillus* spp., *Rhodopseudomonas* spp., *Candida* spp., *Lactobacillus* spp., *Pseudomonas* spp., *Saccharomyces* spp., or *Streptococcus* spp. A disclosed cell-free supernatant composition from a microbial culture wherein the microbial culture is inoculated with *Aspergillus oryzae*, *Bacillus subtilis*, *Lactobacillus helveticus*, *Lactobacillus casei*, *Rhodopseudomonas palustris*, and *Saccharomyces cervisiase*.

In an aspect, a cell-free supernatant composition is filter-sterilized. In an aspect, a cell-free supernatant composition may further comprise one or more of an herbicide, a pesticide, a fungicide, a liquid nutrient composition, or other compounds or compositions that may aid the growth of the desired plants or inhibit the growth of

by the levels of cetic acid, butyric acid, isobutyric acid, and proprionic acid as provided herein.

In an aspect, a cell-free supernatant composition may be prepared from a microbial culture that comprises at least one isolated mycorrhizal fungus. Mycorrhizal fungi increase nutrient uptake in plants by increasing the surface absorbing area of the roots and by releasing powerful enzymes into the soil that dissolve hard-to-capture nutrients, including organic nitrogen, phosphorus, iron and other "tightly bound" soil nutrients. This extraction process is useful in plant nutrition and may indicate why non-mycorrhizal plants require high levels of fertilizer to maintain their health. Mycorrhizal fungi form an intricate web that captures and assimilates nutrients, conserving the nutrient capital in soils.

In an aspect, a cell-free supernatant composition can comprise an agronomically acceptable carrier. Carriers described herein may allow a cell-free supernatant composition to remain efficacious (e.g., capable of increasing plant growth). Non-limiting examples of cell-free supernatant composition comprising a carrier include liquids, gels, slurries, or solids (including wettable powders or dry powders). The selection of the carrier material will depend on the intended application. A carrier may, for example, be a soil-compatible carrier, a seed-compatible carrier and/or a foliar-compatible carrier. In an aspect, a carrier is a soil compatible carrier. In an aspect, a carrier is a seed-compatible carrier. In an aspect, a carrier is a foliar-compatible carrier.

In an aspect, a carrier is a liquid carrier. Non-limiting examples of liquids useful as carriers for compositions disclosed herein include water, an aqueous solution, or a non-aqueous solution. In an aspect, a carrier is water. In an aspect, a carrier is an aqueous solution. In an aspect, a carrier is a non-aqueous solution. If a

2014, under Account No. 200139, with the ATCC Patent Deposit Designation No. PTA-121552, or wherein the *Lactobacillus* spp. is *Lactobacillus plantarum*, IN-LP1, deposited with the ATCC Patent Depository under the Budapest Treaty, on September 4, 2014, with the designation IN-LP1, under Account No. 200139, with the ATCC Patent Deposit Designation No. PTA-121555, or wherein the *Lactobacillus* spp. is *Lactobacillus rhamnosus*, IN-LRI, deposited with the ATCC Patent Depository under the Budapest Treaty, on September 4, 2014, with the designation IN-LRI, under Account No. 200139, with the ATCC Patent Deposit Designation No. PTA-121554. The method, wherein the *Pseudomonas* spp. is *Pseudomonas aeruginosa*. The method wherein the *Rhodopseudomonas* spp. is *Rhodopseudomonas palustris*, or wherein the *Rhodopseudomonas* spp. is *Rhodopseudomonas palustris*, IN-RP1, ATCC Patent Deposit Designation No. PTA-12383, or wherein the *Rhodopseudomonas* spp. is *Rhodopseudomonas palustris*, IN-RP2, deposited with the ATCC Patent Depository under the Budapest Treaty, on September 4, 2014, with the designation IN-RP2, under Account No. 200139, with the ATCC Patent Deposit Designation No. PTA-121553. The method wherein the *Saccharomyces* spp. is *Saccharomyces cerevisiae*, or wherein the *Saccharomyces* spp. is *Saccharomyces cerevisiae*, IN-SC1, ATCC Patent Deposit Designation No. PTA-12384. The method wherein the *Streptococcus* spp. is *Streptococcus lactis*. The method wherein the microbial culture further comprises least one isolated mycorrhizal fungus. The method wherein the microbial culture is inoculated with of at least two of *Aspergillus* spp., *Bacillus* spp., *Rhodopseudomonas* spp., *Candida* spp., *Lactobacillus* spp., *Pseudomonas* spp., *Saccharomyces* spp., or *Streptococcus* spp. The method wherein the microbial culture is inoculated with *Aspergillus oryzae*, *Bacillus subtilis*, *Lactobacillus helveticus*, *Lactobacillus casei*, *Rhodopseudomonas palustris*, and *Saccharomyces cervisiase*. The method wherein

CLAIMS

What is claimed is:

1. A composition comprising:

(i) an isolated cell-free supernatant of a microbial culture obtained by (1) inoculating an isolated mixed microbial composition comprising isolated microorganisms of either IN-Ml, ATCC Patent Deposit Designation No. PTA-12383 into a culture media comprising water, molasses, mineral powder, sea salt, and wheat bran, (2) incubating the inoculated media for 3-10 weeks at 30-32 or 35-37 or 32-37 degrees Celsius, thereby obtaining the microbial culture, and (3) centrifuging the microbial culture to separate microbial culture cells from a supernatant and filter sterilizing the supernatant to obtain the cell-free supernatant of the microbial culture, wherein the cell free supernatant comprises high levels of potassium, nitrogen, calcium, and magnesium, and significant levels of volatile fatty acids, and

(ii) diluent water,

wherein the ratio between the cell-free supernatant of the microbial culture and the diluent water in the cell-free supernatant composition is between 1:25 and 1:1000.

2. The cell-free supernatant composition of claim 1, further comprising a herbicide.

3. The cell-free supernatant composition of claim 1, further comprising a pesticide.

4. The cell-free supernatant composition of claim 1, further comprising a fungicide.

5. The cell-free supernatant composition of claim 1, further comprising a liquid nutrient solution for enabling plant growth.

6. The cell-free supernatant composition of claim 1, wherein said isolated mixed microbial composition further comprises at least one isolated mycorrhizal fungus.

7. The cell-free supernatant composition of claim 1, wherein the culture media comprises non-sulphur agricultural molasses, wheat bran (0.02-0.05% by volume),

kelp (0.02-0.05% by volume), bentonite clay (0.02-0.05% by volume), fish emulsion, soy flour (0.005-0.03% by volume), and sea salt.

8. The cell-free supernatant composition of claim 1, wherein the cell free supernatant comprises about 2500 micrograms potassium per gram of cell-free supernatant, 435-600 micrograms nitrogen per gram of cell-free supernatant, 475-660 micrograms calcium per gram of cell-free supernatant, and 200-260 micrograms magnesium per gram of cell-free supernatant.

9. The cell-free supernatant composition of claim 1, wherein the microbial culture is centrifuged at a centrifugal force of at least 14,000 x g for at least 10 minutes.

10. The cell-free supernatant composition of claim 1, wherein the supernatant is filter sterilized with a 0.22 micron filter.

11. The cell-free supernatant composition of claim 1, wherein

the culture media comprises non-sulphur agricultural molasses, wheat bran (0.02-0.05% by volume), kelp (0.02-0.05% by volume), bentonite clay (0.02-0.05% by volume), fish emulsion, soy flour (0.005-0.03% by volume), and sea salt;

the microbial culture is centrifuged at a centrifugal force of at least 14,000 x g for at least 10 minutes;

the supernatant is filter sterilized with a 0.22 micron filter; and

the cell free supernatant comprises about 2500 micrograms potassium per gram of cell-free supernatant, 435-600 micrograms nitrogen per gram of cell-free supernatant, 475-660 micrograms calcium per gram of cell-free supernatant, and 200-260 micrograms magnesium per gram of cell-free supernatant.

12. A composition comprising an agronomically acceptable carrier and an effective amount of the cell-free supernatant composition of any of claims 1-11.

13. A method of enhancing plant growth comprising providing a cell-free supernatant composition of any of claims 1-11 or the composition of claim 12 to a seed, to a

plant, or to a plant at a particular growth stage, or combinations thereof, thereby enhancing plant growth, wherein the plant is a crop plant.

14. The method of claim 13, wherein providing the cell-free supernatant composition comprises applying the cell-free supernatant to the seeds of plants.

15. The method of claim 13, wherein providing the cell-free supernatant composition comprises applying the cell-free supernatant to the roots of plants.

16. The method of claim 13, wherein providing the cell-free supernatant composition comprises applying the cell-free supernatant to the leaves or stalks of plants.

17. The method of claim 13, wherein the plant is grown in a greenhouse.

18. The method of claim 13, wherein the plant is grown in a field.

19. The method of claim 13, wherein enhancing plant growth is an increase in leaf area or dry biomass.