COMPOSITIONS AND RELATED METHODS FOR AGRICULTURE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application No. 62/450,045, filed on January 24, 2017, and U.S. Provisional Application No. 62/583,763, filed on November 9, 2017, the contents of which are hereby incorporated herein by reference in their entireties.

BACKGROUND

Arthropod insects are pervasive in the human environment, and a multitude of means have been utilized for attempting to control infestations by these pests. The demand for pest control strategies is increasing. Thus, there is need in the art for new methods and compositions to control agricultural insect pests.

SUMMARY

Disclosed herein are compositions and methods for modulating the fitness of insects for agriculture. The composition includes an agent that alters a level, activity, or metabolism of one or more microorganisms resident in a host, the alteration resulting in a modulation in the host's fitness.

In one aspect, the present disclosure refers to a method for aphid control, comprising: decreasing the fitness of an aphid, by delivering to the aphid a composition comprising an antimicrobial peptide and a cell penetrating peptide, wherein: (i) the antimicrobial peptide is chosen from scorpion peptide Uy192 (SEQ ID NO: 232), cecropin (SEQ ID NO: 82), melittin, copsin, drosomycin (SEQ ID NO: 93), dermcidin (SEQ ID NO: 81), andropin (SEQ ID NO: 83), moricin (SEQ ID NO: 84), ceratotoxin (SEQ ID NO: 85), abaecin (SEQ ID NO: 86), apidaecin (SEQ ID NO: 87), prophenin (SEQ ID NO: 88), indolicidin (SEQ ID NO: 89), protegrin (SEQ ID NO: 90), tachyplesin (SEQ ID NO: 91), Uy192 (SEQ ID NO: 232), UyCT3 (SEQ ID NO: 233), D3 (SEQ ID NO: 234), D10 (SEQ ID NO: 235), Uy17 (SEQ ID NO: 236), and defensin (SEQ ID NO: 92) and (ii) the cell penetrating peptide has an amino acid sequence selected from the group consisting of SEQ ID NOs: 213-220 and SEQ ID NO: 242; wherein the antimicrobial peptide targets a microorganism resident in the aphid, whereby the aphid's fitness is decreased, relative to a control aphid not treated with the composition.

In one example, provided herein is a method of decreasing fitness of an agricultural insect pest, the method including delivering an antimicrobial peptide having at least 90% sequence identity (e.g., at least 90%, 92%, 94%, 96%, 98%, or 100% sequence identity) with one or more of the following: cecropin (SEQ ID NO: 82), melittin, copsin, drosomycin (SEQ ID NO: 93), dermcidin (SEQ ID NO: 81), andropin (SEQ ID NO: 83), moricin (SEQ ID NO: 84), ceratotoxin (SEQ ID NO: 85), abaecin (SEQ ID NO: 86), apidaecin (SEQ ID NO: 87), prophenin (SEQ ID NO: 88), indolicidin (SEQ ID NO: 89), protegrin (SEQ ID NO: 90), tachyplesin (SEQ ID NO: 91), or defensin (SEQ ID NO: 92) to the agricultural insect pest.

In some examples, the delivery may include delivering the antimicrobial peptide to at least one habitat where the agricultural insect pest grows, lives, reproduces, feeds, or infests.

In any of the above examples, the delivery may include spraying the antimicrobial peptide on an agricultural crop.

In any of the above examples, the antimicrobial peptide may be delivered as an insect comestible composition for ingestion by the agricultural insect pest.

In any of the above examples, the antimicrobial peptide may be formulated with an agriculturally acceptable carrier as a liquid, a solid, an aerosol, a paste, a gel, or a gas composition.

In any of the above examples, the agricultural insect pest may be an aphid.

In another example, provided herein is a composition including an antimicrobial peptide having at least 90% sequence identity (e.g., at least 90%, 92%, 94%, 96%, 98%, or 100% sequence identity) with one or more of the following: cecropin (SEQ ID NO: 82), melittin, copsin, drosomycin (SEQ ID NO: 93), dermcidin (SEQ ID NO: 81), andropin (SEQ ID NO: 83), moricin (SEQ ID NO: 84), ceratotoxin (SEQ ID NO: 85), abaecin (SEQ ID NO: 86), apidaecin (SEQ ID NO: 87), prophenin (SEQ ID NO: 88), indolicidin (SEQ ID NO: 89), protegrin (SEQ ID NO: 90), tachyplesin (SEQ ID NO: 91), or defensin (SEQ ID NO: 92) formulated for targeting a microorganism in an insect.

CLAIMS

1. A method for aphid control, comprising: decreasing the fitness of an aphid, by delivering to the aphid a composition comprising an antimicrobial peptide and a cell penetrating peptide, wherein: (i) the antimicrobial peptide is chosen from scorpion peptide Uy192 (SEQ ID NO: 232), cecropin (SEQ ID NO: 82), melittin, copsin, drosomycin (SEQ ID NO: 93), dermcidin (SEQ ID NO: 81), andropin (SEQ ID NO: 83), moricin (SEQ ID NO: 84), ceratotoxin (SEQ ID NO: 85), abaecin (SEQ ID NO: 86), apidaecin (SEQ ID NO: 87), prophenin (SEQ ID NO: 88), indolicidin (SEQ ID NO: 89), protegrin (SEQ ID NO: 90), tachyplesin (SEQ ID NO: 91), Uy192 (SEQ ID NO: 232), UyCT3 (SEQ ID NO: 233), D3 (SEQ ID NO: 234), D10 (SEQ ID NO: 235), Uy17 (SEQ ID NO: 236), and defensin (SEQ ID NO: 92) and (ii) the cell penetrating peptide has an amino acid sequence selected from the group consisting of SEQ ID NOs: 213-220 and SEQ ID NO: 242; wherein the antimicrobial peptide targets a microorganism resident in the aphid, whereby the aphid's fitness is decreased, relative to a control aphid not treated with the composition.

2. The method of claim 1, wherein the microorganism is an obligate symbiont of the aphid.

3. The method of claim 1 or 2, wherein the composition is formulated for delivery to a plant on which the aphid grows, lives, reproduces, feeds, or infests.

4. The method of claim 3, wherein the delivering comprises spraying the plant with the composition.

5. The method of any one of claims 1-4, wherein the composition is formulated as an insect comestible composition for ingestion by the aphid.

6. The method of claim 3, wherein the composition is provided to the aphid as a plant that has been genetically engineered to produce the antimicrobial peptide and the cell penetrating peptide.

7. The method of claim 1, wherein the antimicrobial peptide is scorpion peptide Uy192 or dermcidin (SEQ ID NO:81).

8. The method of claim 2, wherein the obligate symbiont is Buchnera.

9. The method of any one of claims 1-8, wherein the composition further comprises at least one agent selected from an antibiotic and a natural antimicrobial.

10. The method of claim 1 or 7, wherein the antimicrobial peptide and the cell penetrating peptide are a fusion peptide.

11. The method of claim 10, wherein the fusion peptide has the amino acid sequence of SEQ ID NO: 237.

12. The method of claim 1, wherein the decrease in fitness of the aphid comprises at least one of: (a) a delay in the aphid's development; (b) an increase in the aphid's mortality; and (c) a reduction in the aphid's endosymbiont levels.

13. The method of claim 10, wherein the fusion peptide penetrates bacteriocytes of the aphid.