SUMMARY

[0004a] In one aspect, the present disclosure refers to a granular composition for agricultural use comprising:

a plurality of granulates having at least a first biodegradable coating layer applied over the granulates and a second biodegradable coating layer applied over the first biodegradable coating layer,

wherein the granulates comprise a material selected from the group consisting of seeds, fertilizers, and pesticides,

wherein the first biodegradable coating layer comprises polyhydroxyalkanoates comprising from about 70 to about 99 mole percent monomer residues of hydroxybutyrates and from about 1 to about 30 mole percent monomer residues of a different hydroxyalkanoate having from 5 to 22 carbon atoms, and

wherein the second biodegradable coating layer comprises at least polymer selected from the group consisting of polycaprolactone, polylactic acid, polybutylene succinate, polybutylene succinate-co-adipate, mesolactide, polybutylene adipate-co-terephthalate, polyvinyl alcohol, polyvinyl acetate, cellulose esters, polysaccharides, polyglycolic acid, polymaleic acid and mixtures thereof.

[0004b] In another aspect, the present disclosure refers to a method for controlled release of a granular material, comprising the steps of:

providing a granular composition disclosed herein;

dispersing the granular composition over a plot of soil;

dissolving at least the polyhydroxyalkanoates in the first biodegradable coating layer by exposing the plot of soil, and the granular composition dispersed therein, to moisture,

wherein dissolution of the polyhydroxyalkanoates releases the granulate into the soil.

[0005] The above and other needs are met by a granular composition for agricultural use in accordance with the current disclosure. According to one example, this granular composition is made up of a plurality of granulates having a first biodegradable coating layer

applied over the granulates. These granulates in turn are made up of a material selected from the group consisting of seeds, fertilizers, and pesticides. The first biodegradable coating is made up of polyhydroxyalkanoates, and these polyhydroxyalkanoates include from about 70 to about 99 mole percent monomer residues of hydroxybutyrates and from about 1 to about 30 mole percent monomer residues of a different hydroxyalkanoate having from 5 to 22 carbon atoms.

[0006] In some instances, the polyhydroxyalkanoates are preferably made up of from about 70 to about 99 mole percent monomer residues of 3-hydroxybutyrate. Also, in some instances, the polyhydroxyalkanoates are preferably made up of from about 1 to about 30 mole percent monomer residues of 3-hydroxyhexanoate.

[0007] In certain examples, the granulates of the composition are preferably made up of seeds. In other examples, the granulates of the composition are preferably made up of fertilizer, more preferably a urea-based fertilizer. In still further examples, the granulates of the composition are preferably made up of a pesticide.

[0008] In certain examples, the first biodegradable coating layer preferably includes polyhydroxyalkanoates having a weight average molecular weight from about 50,000 to about 2.5 million Daltons.

[0009] In certain examples, the granulates preferably have an average particle size, before coating, from about 1 mm to about 25 mm.

[0010] In certain examples, the polyhydroxyalkanoates may also include monomer residues of 3-hydroxyvalerate, 4-hydroxyvalerate, and/ or 5-hydroxyvalerate.

[0011] Moreover, in some instances, the polyhydroxyalkanoates are preferably made up of three or more different types of hydroxyalkanoate monomer residues, each having from 5 to 22 carbon atoms.

[0012] In certain examples, the first biodegradable coating layer also includes at least one polymer selected from the group consisting of polycaprolactone, polylactic acid, polybutylene succinate, polybutylene succinate-co-adipate, polyvinyl alcohol, polyvinyl acetate, cellulose esters, polysaccharides, polybutylene adipate co butylene terephthalate, polyglycolic acid, polymaleic acid, and mixtures thereof.

[0013] In certain examples, the first biodegradable coating layer also includes from about 5 to about 95 weight percent polycaprolactone.

[0014] In a preferred example, the first biodegradable coating layer is made up of less than one weight percent polyurethane. More preferably, the first biodegradable coating layer includes no polyurethane at all.

[0015] In certain examples, the first biodegradable coating layer is made up of about 50 to about 95 weight percent polyhydroxyalkanoates and about 5 to about 50 weight percent of a biodegradable polymer other than polyhydroxyalkanoates.

[0016] Further, at least the first biodegradable coating layer starts to dissolve after about 3 to about 21 days exposure to environmental conditions at a temperature of about -5 to about 60 °C and a pH of about 2 to 9. More preferably, at least 10 weight percent of the first biodegradable coating layer is dissolved after about 3 to about 21 days exposure to environmental conditions at a temperature of about 60 to about 100 °F (about 16 to about 38 °C).

[0017] In certain examples, the granular composition may also include a second biodegradable coating layer applied over the first biodegradable coating layer. This second biodegradable coating layer is preferably made up of at least polymer selected from the group consisting of polycaprolactone, polylactic acid, polybutylene succinate, polybutylene succinate-co-adipate, mesolactide, and polybutylene adipate-co-terephthalate, polyvinyl alcohol, polyvinyl acetate, cellulose esters, polysaccharides, polyglycolic acid, polymaleic acid, and mixtures thereof.

[0018] In a further example, the present disclosure provides a method for controlled release of a granular material. According to one example, the method includes an initial step of providing a granular composition made up of a plurality of granulates having a first

biodegradable coating layer applied over the granulates. These granulates in turn are made up of a material selected from the group consisting of seeds, fertilizers, and pesticides. The biodegradable coating is made up of polyhydroxyalkanoates, and theses polyhydroxyalkanoates include from about 70 to about 99 mole percent monomer residues of hydroxybutyrates and from about 1 to about 30 mole percent monomer residues of a different hydroxyalkanoate having from 5 to 22 carbon atoms.

[0019] In a second step, the granular composition is dispersed over a plot of soil.

[0020] At least the polyhydroxyalkanoates in the first biodegradable coating layer is then dissolved by exposing the plot of soil, and the granular composition dispersed therein, to moisture. Dissolution of the polyhydroxyalkanoates releases the granulate material into the soil.

[0021] In some instances, the polyhydroxyalkanoates are preferably made up of from about 70 to about 99 mole percent monomer residues of 3-hydroxybutyrate. Also, in some instances, the polyhydroxyalkanoates are preferably made up of from about 1 to about 30 mole percent monomer residues of 3-hydroxyhexanoate.

[0022] In certain examples of the method, the granulates of the composition are preferably made up of seeds. In other examples of the method, the granulates of the composition are preferably made up of fertilizer, more preferably a urea-based fertilizer. In still further examples, the granulates of the composition are preferably made up of a pesticide.

[0023] In certain examples of the method, the polyhydroxyalkanoates may also include monomer residues of 3-hydroxyvalerate, 4-hydroxyvalerate, and/ or 5-hydroxyvalerate.

[0024] Moreover, in some instances, the polyhydroxyalkanoates are preferably made up of three or more different types of hydroxyalkanoate monomer residues, each having from 5 to 22 carbon atoms.

[0025] In certain examples of the method, the first biodegradable coating layer also includes at least polymer selected from the group consisting of polycaprolactone, polylactic acid, polybutylene succinate, polybutylene succinate-co-adipate, polyvinyl alcohol,

polyvinyl acetate, cellulose esters, polysaccharides, polybutylene adipate co butylene terephthalate, polyglycolic acid, polymaleic acid, and mixtures thereof.

[0026] In certain examples of the method, the first biodegradable coating layer also from about 5 to about 95 weight percent polycaprolactone.

[0027] In a preferred example of the method, the first biodegradable coating layer comprises less than one weight percent polyurethane. More preferably, the first biodegradable coating layer includes no polyurethane at all.

[0028] In certain examples of the method, the first biodegradable coating layer is made up of about 50 to about 95 weight percent polyhydroxyalkanoates and about 5 to about 50 weight percent of a biodegradable polymer other than polyhydroxyalkanoates.

[0029] Further, at least the first biodegradable coating layer starts to dissolve after about 3 to about 21 days exposure to environmental conditions at a temperature of about -5 to about 60 °C and a pH of about 2 to 9. More preferably, at least 10 weight percent of the first biodegradable coating layer is dissolved after about 3 to about 21 days exposure to environmental conditions at a temperature of about 60 to about 100 °F (about 16 to about 38 °C).

[0030] In certain examples of the method, the granular composition may also include a second biodegradable coating layer applied over the first biodegradable coating layer. This second biodegradable coating layer is preferably made up of at least polymer selected from the group consisting of polycaprolactone, polylactic acid, polybutylene succinate, polybutylene succinate-co-adipate, mesolactide, polybutylene adipate-co-terephthalate, polyvinyl alcohol, polyvinyl acetate, cellulose esters, polysaccharides, polybutylene adipate co butylene terephthalate, polyglycolic acid, polymaleic acid, and mixtures thereof.

WHAT IS CLAIMED IS

Claim 1. A granular composition for agricultural use comprising:

a plurality of granulates having at least a first biodegradable coating layer applied over the granulates and a second biodegradable coating layer applied over the first biodegradable coating layer,

wherein the granulates comprise a material selected from the group consisting of seeds, fertilizers, and pesticides,

wherein the first biodegradable coating layer comprises polyhydroxyalkanoates comprising from about 70 to about 99 mole percent monomer residues of hydroxybutyrates and from about 1 to about 30 mole percent monomer residues of a different hydroxyalkanoate having from 5 to 22 carbon atoms, and

wherein the second biodegradable coating layer comprises at least polymer selected from the group consisting of polycaprolactone, polylactic acid, polybutylene succinate, polybutylene succinate-co-adipate, mesolactide, polybutylene adipate-co-terephthalate, polyvinyl alcohol, polyvinyl acetate, cellulose esters, polysaccharides, polyglycolic acid, polymaleic acid and mixtures thereof.

Claim 2. The granular composition of Claim 1, wherein the polyhydroxyalkanoates comprise from about 70 to about 99 mole percent monomer residues of 3-hydroxybutyrate.

Claim 3. The granular composition of Claim 1, wherein the polyhydroxyalkanoates comprise from about 1 to about 30 mole percent monomer residues of 3-hydroxyhexanoate.

Claim 4. The granular composition of Claim 1, wherein the granulates comprise seeds.

Claim 5. The granular composition of Claim 1, wherein the granulates comprise fertilizer.

Claim 6. The granular composition of Claim 1, wherein the granulates comprise pesticide.

Claim 7. The granular composition of Claim 1, wherein the first biodegradable coating layer comprises polyhydroxyalkanoates having a weight average molecular weight from about 50,000 to about 2.5 million Daltons.

Claim 8. The granular composition of Claim 1, wherein the polyhydroxyalkanoates further comprise monomer residues of 3-hydroxyvalerate, 4-hydroxyvalerate, and/ or 5-hydroxyvalerate.

Claim 9. The granular composition of Claim 1, wherein the polyhydroxyalkanoates comprise three or more different types of hydroxyalkanoate monomer residues, each having from 5 to 22 carbon atoms.

Claim 10. The granular composition of Claim 1, wherein the granulates have an average particle size, before coating, from about 1 mm to about 25 mm.

Claim 11. The granular composition of Claim 1, wherein the first biodegradable coating layer further comprises at least polymer selected from the group consisting of polycaprolactone, polylactic acid, polybutylene succinate, polybutylene succinate-co-adipate, polyvinyl alcohol, polyvinyl acetate, cellulose esters, polysaccharides, polybutylene adipate co butylene terephthalate, polyglycolic acid, polymaleic acid, and mixtures thereof.

Claim 12. The granular composition of Claim 1, wherein the first biodegradable coating layer further comprises from about 5 to about 95 weight percent polycaprolactone.

Claim 13. The granular composition of Claim 1, wherein the first biodegradable coating layer comprises less than one weight percent polyurethane.

Claim 14. The granular composition of Claim 1, wherein the first biodegradable coating layer comprises about 50 to about 95 weight percent polyhydroxyalkanoates and about 5 to about 50 weight percent of a biodegradable polymer other than polyhydroxyalkanoates and wherein at least the first biodegradable coating layer starts to dissolve after about 3 to about 21 days exposure to environmental conditions at a temp of -5 to 60 °C and a pH of about 2 to 9.

Claim 15. A method for controlled release of a granular material, comprising the steps of:

providing a granular composition according to any of Claims 1-14;

dispersing the granular composition over a plot of soil;

dissolving at least the polyhydroxyalkanoates in the first biodegradable coating layer by exposing the plot of soil, and the granular composition dispersed therein, to moisture,

wherein dissolution of the polyhydroxyalkanoates releases the granulate into the soil.