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(54) Title: FERTILISER COMPOSITION

(57) Abstract: The present invention provides fertiliser compositions comprising granules comprising a substrate core coated in one or more polymeric binders and one or more plant hormones, such as auxin or gibberellic acid or a salt thereof, in addition to methods of manufacturing and using such compositions and granules, for example for improving plant health and production, such as treating the soil of pastoral land to increase pasture production.

FERTILISER COMPOSITION

FIELD OF THE INVENTION

[0001] The present invention relates to compositions comprising granules of plant hormones and one or more polymeric binders, methods of preparing such compositions, and application of such compositions to soil.

BACKGROUND TO THE INVENTION

[0002] The agricultural (including horticultural) use of liquid formulations of plant hormones is known. For example, Gibberellic acid (GA), is applied to plants in liquid formulations typically by foliar spraying (see Khan NA *et al.,* (1996) "Effect of gibberellic acid and nitrogen on carbonic anhydrase activity and mustard biomass" in *Biologia Plantarum* volume 38 at pages 601–603), or seeds are soaked in GA (see Khan NA *et al.,* (1996) "Effect of gibberellic acid spray on nitrogen yield efficiency of mustard grown with different nitrogen levels" in *Plant Growth Regulation* volume 38 at pages 243–247).

[0003] There remains a need for agriculturally acceptable compositions comprising plant hormones that do not need to be formulated or applied as a liquid.

[0004] It is an object of the present invention to provide agriculturally acceptable compositions comprising granules of plant hormone and one or more polymeric binders, to provide said granules, for example a granule containing gibberellic acid, to provide methods of preparing and using said compositions and granules, or to at least provide the public with a useful choice.

SUMMARY OF THE INVENTION

[0005] The invention broadly relates to one or more granules, the granules comprising a substrate core, one or more polymeric binders, and one or more plant hormones about the substrate core.

[0006] In one aspect the invention relates to granules, the granules comprising

- a substrate core,
- a coating on the substrate core comprising a plant hormone, and

- about 0.025 to about 1 g/kg of substrate core of a polymeric binder present as
  - i) a first coating on the substrate core (prior to the plant hormone-containing coating),
  - ii) a mixture with the plant hormone, or
  - iii) both i) and ii).

[0007] In a further aspect the invention relates to one or more granules, the granules comprising a substrate, a polymeric binder, and one or more plant hormones, wherein the granules

a) have a bulk density of from about 0.5 g/cm^3 to about 1.5 g/cm^3, or
b) have a mean diameter (weight-based) of from about 1 mm to 5 mm, or
c) have a particle size distribution whereby at least 90% of the granules have a diameter of from 1 mm to 5 mm, or
d) have a particle size distribution whereby at least 90% of the granules have a diameter within 1 mm of the mean diameter, or
e) have a hardness of from about 10 N to about 70 N, or
f) comprise less than about 0.5% w/w plant hormone, or
g) any combination of two or more of (a) to (f).

[0008] In a further aspect the invention relates to a **fertiliser composition** comprising the granules of the present invention.

[0009] In a further aspect the invention relates to **a method of producing a granule**, the method comprising

- providing a substrate core, a polymeric binder and a plant hormone,
- at least partially coating the substrate core with a coating that comprises the plant hormone,
- wherein the polymeric binder is
  - i) at least partially coated on the substrate core as a first coating (prior to the plant hormone-containing coating),
  - ii) mixed with the plant hormone, or
  - iii) both i) and ii).

[0010] In another aspect the invention relates to **a method** of providing fertilizer to a plant or a locus at which a plant is or is to be planted, the method comprising applying granules comprising a substrate core coated with a polymeric binder and one or more

plant hormones to the plant or the locus, for example to the soil of pastoral or arable land, or to the media in which or surfaces on which plants are grown, for example, in horticultural greenhouses and the like.

[0011] In one aspect the invention relates to a method of improving plant health, production, or nutritional, environmental or economic value, or of improving the health-promoting or productive capacity or the nutritional, environmental or economic value of a locus where a plant is or is to be planted, the method comprising applying a composition of the invention or granules of the invention to the plant or the locus.

[0012] In one embodiment, the improvement is an improvement in yield. For example, the plant to which the composition or granules of the invention is applied is a crop plant, wherein the improvement is an improvement in crop yield.

[0013] In one embodiment the improvement is a reduction in plant nitrogen concentration.

[0014] In one embodiment, the improvement is a reduction in plant cadmium concentration, or in cadmium concentration of the locus.

[0015] In another embodiment, the improvement is a reduction in nitrate levels in the plant, or present in the locus, and/or nitrate poisoning risk to animals grazing.

[0016] In another embodiment, the improvement is a reduction in cadmium intake by grazing animals, or in cadmium concentration in the grazing animals or a product from or output of said animals.

[0017] In another embodiment, the improvement is a reduction in the nitrogen concentration of forage grazed by an animal or reduction in the nitrogen concentration of a product of or output from a grazing animal. For example, in an exemplary embodiment the improvement is a reduction in the nitrogen or urea concentration of milk from a grazing animal, such as a bovine, or a reduction in the nitrogen concentration of meat from a grazing animal, such as a bovine, or a reduction in urine nitrogen concentration.

[0018] In another embodiment, the improvement is a reduction in cation leaching, for example, cation leaching in or from the locus.

[0019] In another embodiment, the improvement is a reduction in nitrous oxide production, for example, nitrous oxide production in or from the locus.

[0020] In another embodiment, the improvement is a reduction in nitrogen leaching, for example, nitrogen leaching in or from the locus.

[0021] In another aspect the invention relates to **a method of treating the soil of pastoral land to increase pasture production, the method** comprising applying granules comprising a substrate core coated with a polymeric binder, and one or more plant hormones to the soil of pastoral land to increase pasture production.

[0022] For example, in one embodiment the plant hormone is gibberellic acid or a salt thereof, such that the invention relates to **a method of treating the soil of pastoral land to increase pasture production, the method** comprising applying granules comprising gibberellic acid or a salt thereof, a polymeric binder and optionally one or more carriers and/or one or more additional agents to the soil of pastoral land to increase pasture production.

[0023] In another aspect the invention relates to **use of granules comprising one or more plant hormones** and a polymeric binder and optionally one or more carriers and/or one or more additional agents to increase pasture production on pastoral land.

[0024] For example, in one embodiment the plant hormone is gibberellic acid or a salt thereof, such that the invention relates to **use of granules comprising gibberellic acid or a salt thereof, and** a polymeric binder and optionally one or more carriers and/or one or more additional agents to increase pasture production on pastoral land.

[0025] Any one or more of the following embodiments may relate to any of the aspects described herein.

[0026] In various embodiments the substrate is selected from the group comprising a clay granule, a silicate mineral, an aluminosilicate mineral, for example, zeolite, diatomaceous earth or perlite, vermiculite, a seed, for example, a vegetable seed, a fertiliser granule, or a combination of any two or more thereof. In various embodiments the substrate may comprise a seed, for example an angiosperm, vegetable, legume, cereal or conifer seed. In various embodiments the seed comprises a spinach, carrot, onion, soybean, lucerne, plantain, brassica, maize rye grass, canola or clover seed. In various embodiments the substrate may comprise wheat, barley, bran, maize, rye, rice, sorghum, millet, oats, forage brassica, canola or triticale, or a combination of any two or more thereof. In various embodiments the substrate may comprise a granule comprising a fertiliser, for example, a granule of urea, superphosphate, monoammonium phosphate

(MAP), diammonium phosphate (DAP, single superphosphate (SSP), triple superphosphate (TSP), calcium ammonium nitrate (CAN) or muriate of potash (MOP).

[0027] In one embodiment the substrate include a nitrification inhibitor.

[0028] In one embodiment the a polymeric binder is first coated on the substrate core to at least partially coat the substrate core, prior to the addition of a further coating that comprises a plant hormone, to at least partially coat the binder-coated substrate core.

[0029] In an alternate embodiment the a polymeric binder is mixed with the plant hormone, the mix forming a coating about the substrate core, to at least partially coat the substrate core.

[0030] In various embodiments the polymeric binder(s) may be a polyhydroxyl compound, a polymer or copolymer of a C_1–C_6 alkyl substituted with one or more groups selected from the group comprising lactams, preferably γ-lactam, or 2-pyrollidone, a latex, or a starch, or a combination thereof.

[0031] In various embodiments the polyhydroxyl compound may comprise at least 2, 3, 4, 5, 10, 20, 50, 100, 200, 300, 400, 500, 750, 800, 1,000, 1,200, about 1,500, about 2,000, about 3,000, about 4,000 or at least about 5,000 hydroxyl groups.

[0032] In various embodiments the polymeric compound may have an average molecular weight of about 5, 10, 20, 22.5, 24.5, 25, 30, 40, 50, 75, 80, 90, 100, 118, 120, 125, 126, 130, 140, 150, 200, 250, 300 or about 350 kDa,

[0033] In various embodiments the polyhydroxyl compound may be selected from the group comprising a polyvinyl alcohol, a polyethylene oxide, methyl cellulose, a polyvinyl alcohol-polyethylene glycol co-polymer (e.g. Kollicoat® Protect), gum Arabic or a starch. In a particularly preferred embodiment the polyhydroxyl compound is a polyvinyl alcohol.

[0034] In one embodiment the polyhydroxyl compound may be a polymer or copolymer Of (1) a C_2–C_6 hydroxyalkyl, or (2) a C_2–C_{10} hydroxyalkyl, optionally substituted with acyl and/or optionally comprising an ether moiety, for example, methacrylic acid-ethyl acrylate copolymer (Kollicoat® MAE100).

[0035] In various embodiments the polyhydroxyl compound may have a degree of hydrolysis of at least about 80, 82.5, 85, 87.5, 90, 92.5, 95 or 98 mol.

[0036] In various embodiments the polymeric binder may be a polymer or copolymer of a C_1–C_6 alkyl substituted with one or more groups selected from the group comprising lactams, preferably γ-lactam, or 2-pyrollidone. In one embodiment the polymeric binder may be polyvinylpyrrolidone.

[0037] In various embodiments the polymeric binder may be selected from the group comprising copolymers of vinyl pyrrolidone, and vinyl acetate, poly (methyl vinyl ether), maleic anhydride copolymers, free acids of the copolymer of methyl vinyl ether and maleic anhydride, vinyl pyrrolidone/styrene copolymers, vinyl acetate/butyl acrylate copolymers, vinyl acetate homopolymers, acrylic copolymers, styrene/acrylic ester copolymers, vinyl acetate/ethylene copolymers and polyvinyl acetate, or a combination of any two or more thereof.

[0038] In one embodiment the polymer is a short chain polymer. For example, having about 7000 to about 10,000 units.

[0039] In one embodiment the polymer is a long chain polymer. For example, having about 80,000 to about 150,000 units.

[0040] In one embodiment the polymeric binder may be a latex polymer, for example, EC 23009.

[0041] In one embodiment the polymeric binder is a starch such as potato starch or a pregelatinised starch.

[0042] In various embodiments, the one or more plant hormones are selected from the group consisting of one or more gibberellins, one or more auxins, one or more cytokinins, abscisic acid, ethylene, salicylic acid, one or more brassinosteroids, one or more jasmonates, one or more peptide hormones, one or more polyamines, nitric oxide, and one or more strigolactones.

[0043] In one embodiment the one or more gibberellins is a gibberellic acid or a slat thereof. In one embodiment the gibberellin is a mixture of giberelic acids, or a salt thereof. In one embodiment the gibberellins is a mixture of GA4 and GA7.

[0044] In one embodiment, the one or more auxins is indole-3-acetic acid (IAA), 1-Naphthaleneacetic acid (NAA), or indole-3-butyric acid (IBA). In one embodiment, the cytokinin is zeatin. In one embodiment, the brassinosteroids is brassinolide.

[0045] In one embodiment the granule comprises a surfactant. In one embodiment the surfactant is a nonionic surfactant, anionic surfactant, cationic surfactant and/or amphoteric surfactant.

[0046] In one embodiment the surfactant is

i) mixed with the polymeric binder and applied as a first layer about the substrate core, to at least partially coat the substrate core,
ii) is mixed with the plant hormone and applied as a coating on the substrate core to at least partially coat the substrate core, or
iii) both i) and ii) above.

[0047] In one embodiment the granules comprise one or more carriers coated with one or more plant hormones, such as gibberellic acid or a salt thereof, and one or more polymeric binders. Accordingly, in certain embodiments the granules comprise a carrier core, directly or indirectly coated with one or more plant hormones and one or more polymeric binders.

[0048] In one embodiment, the granules comprise a carrier core to which it is applied a polymeric binder, one or more plant hormones, optionally together with one or more agriculturally acceptable carriers.

[0049] In some embodiments the first coating about the substrate core comprises a biodegradable polymer.

[0050] In one embodiment the biodegradable polymer may comprise a polysaccharide.

[0051] In one embodiment the biodegradable polymer may comprise an exopolysaccharide produced by a microorganism, for example, an exopolysaccharide produced by *Achromobacter, Acetobacter, Acinetobacter, Agrobacterium, Alcaligenes, Aspergillus, Aureobasidium, Aureomonas, Azotobacter, Bacillus, Beijerinckia, Lactobacillus, Lentinus, Leuconostoc, Mucorales, Pantoea stewartii, Pseudomonas, Rhizobium, Schizophylum, Sclerotium, Serratia, Sinorhizobium, Sphingomonas, Streptococcus, Xanthomonas, Zooglea,* or *Zymomonas* spp.

[0052] In one embodiment the biodegradable polymer may comprise a gum such as a plant gum. In various embodiments the biodegradable polymer may be selected from the group comprising xanthan gum, agar, alginate, cassia, dammar, pectin, beta-glucan, glucomannan, mastic, chicle, psyllium, spruce gum, gellan gum, acacia gum, guar gum, locust bean gum, carrageenans, gum arabic, karaya gum, ghatti gum, tragacanth gum, konjac gum, tara gum, pullulan or a combination of any two or more thereof.

[0053] In one embodiment the biodegradable polymer may comprise a synthetic polysaccharide, for example a synthetic polymer of sucrose. In one embodiment the polysaccharide may comprise Ficoll®.

[0054] In one embodiment the granules comprise a substantially homogeneous mixture of one or more plant hormones, urea and optionally one or more carriers and/or one or more additional agents.

[0055] In one embodiment the granules comprise a substantially homogeneous mixture of one or more carriers and/or one or more additional agents and one or more plant hormones.

[0056] In one embodiment, the granules comprise one or more additional agents, such as one or more fertilizers, one or more trace elements, one or more nitrification inhibitors, one or more urease inhibitors, or other agents.

[0057] In one embodiment the granule comprises a biodegradable polymer.

[0058] In one embodiment the biodegradable polymer may comprise an exopolysaccharide produced by a microorganism, for example, an exopolysaccharide produced by *Achromobacter, Acetobacter, Acinetobacter, Agrobacterium, Alcaligenes, Aspergillus,Aureobasidium, Aureomonas, Azotobacter, Bacillus, Beijerinckia, Lactobacillus, Lentinus, Leuconostoc, Mucorales, Pantoea stewartii, Pseudomonas, Rhizobium, Schizophylum, Sclerotium, Serratia, Sinorhizobium, Sphingomonas, Streptococcus, Xanthomonas, Zooglea,* or *Zymomonas* spp.

[0059] In one embodiment the biodegradable polymer may comprise a gum such as a plant gum.

[0060] In various embodiments the biodegradable polymer may be selected from the group comprising xanthan gum, agar, alginate, cassia, dammar, pectin, beta-glucan,

glucomannan, mastic, chicle, psyllium, spruce gum, gellan gum, acacia gum, guar gum, locust bean gum, carrageenans, gum arabic, karaya gum, ghatti gum, tragacanth gum, konjac gum, tara gum, pullulan or a combination of any two or more thereof.

[0061] In one embodiment the biodegradable polymer may comprise a synthetic polysaccharide, for example a synthetic polymer of sucrose. In one embodiment the polysaccharide may comprise Ficoll®.

[0062] In various embodiments the granules have a mean diameter of about 500, 600, 700, 800, 900, 1000, 1200, 1400, 1600, 1800, 2000, 2200, 2400, 2600, 2800, 3000, 3200, 3400, 3600, 3800, 4000, 4200, 4400, 4600, 4800 or 5,000 μm, and useful ranges may be selected between any of these values.

[0063] In various embodiments the granules have a mean diameter of about 500 to about 5,000 μm. Preferably the granules have a mean diameter of about 2,000 to about 4,000 μm.

[0064] In various embodiments, the granules have a hardness of from about 10 N to about 70 N. For example, in one embodiment the granules have a hardness of from about 20 N to about 60 N, of from about 20 N to about 50 N, or of from about 30 N to about 50 N.

[0065] In one embodiment the a substrate core is coated with a first coating comprising about 0.025 to about 1 g/kg of substrate core of a polymeric binder, and a further coating, comprising a plant hormone, that at least partially coats the coated substrate core.

[0066] In an alternate embodiment the substrate core is coated with a coating that comprises a mixture of about 0.025 to about 1 g/kg of substrate core of a polymeric binder and a plant hormone.

[0067] In one embodiment granules are prepared by a method comprising

(A) providing a substrate core, a polymeric binder, one or more plant hormones, and optionally one or more additional agents,

(B) forming granules comprising the substrate core, polymeric binder, and plant hormone and optionally the one or more additional agents by

i) wet or dry mixing the substrate core, the one or more polymeric binders, and optionally the one or more additional agents and granulating the mixture, or

ii) granulating the substrate core and at least partially coating the granule with the one or more polymeric binders, and optionally the one or more additional agents, and

iii) at least partially coating the granule with the one or more plant hormones,

iv) any combination of (i) to (iii) above, and

(C) recovering the granules.

[0068] In one embodiment the granules consist of a granule at least partially dry coated with the one or more plant hormones, such as gibberellic acid or a salt thereof.

[0069] In one embodiment the granules consist of a granule at least partially wet coated with one or more plant hormones, such as gibberellic acid or a salt thereof.

[0070] In one embodiment the granules comprise about 0.01, 0.05, 0.1, 0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, 0.95, 1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9 or 3 mg plant hormone per gram of granule.

[0071] In one example the granules comprise about 0.01, 0.05, 0.1, 0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, 0.95, 1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9 or 3 mg gibberellic acid or salt thereof per gram of granule.

[0072] In various embodiments, the granules comprise less than about 0.5% w/w plant hormone, less than about 0.4% w/w plant hormone, less than about 0.3% w/w plant hormone, less than about 0.2% w/w plant hormone, less than about 0.1% w/w plant hormone, or less than about 0.05% w/w plant hormone.

[0073] In one embodiment the one or more plant hormones, such as the gibberellic acid or a salt thereof, at least partially coats the granule surface.

[0074] In one embodiment the granule comprises urea, such as urea sourced from urea phosphate, urea sulphur, urea potash or a mixture thereof.

[0075] In one embodiment the granule comprises one or more carriers and/or one or more additional agents and one or more plant hormones as a granule comprising the one or more plant hormones in a carrier, encapsulated or coated by one or more carriers or one or more additional agents. In one embodiment, the granule of one or more plant hormones is formed with a carrier. In some embodiments the carrier is selected from a clay such as a potassium, sodium, calcium, or aluminium bentonite, a zeolite (e.g. mordenite) or perlite, or a combination thereof. In one embodiment, once the plant hormone granule is formed, the urea is applied to the granule.

[0076] In one particularly contemplated embodiment the granule comprises one or more carriers and/or one or more additional agents and gibberellic acid as a granule comprising gibberellic acid in a carrier, encapsulated or coated by one or more carriers and/or one or more additional agents.

[0077] In various embodiments, the one or more plant hormones coats at least 10%, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90 or 95% of the granule surface.

[0078] For example, the gibberellic acid or a salt thereof coats at least 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90 or 95% of the granule surface.

[0079] In particularly contemplated embodiments, the one or more plant hormones, such as the gibberellic acid or a salt thereof, the coats at least 75% of the granule surface.

[0080] In one embodiment, the one or more plant hormones, such as the gibberellic acid or a salt thereof, is sprayed onto the granules.

[0081] In various embodiments, the composition or granules of the invention are applied to a plant or a locus where a plant is or is to be planted, for example using standard solid-phase distribution techniques. For example, granules of the invention are blown or disbursed over a locus where one or more plants are or are to be planted. In one exemplary embodiment the granules are sprayed or blown onto a pasture.

[0082] In one embodiment the granules are applied to substantially cover the locus, for example a pasture.

[0083] In one embodiment the granules are applied to provide about 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95 or 100 g/Ha of one or more plant hormones, and useful ranges may be selected between any of these values.

[0084] For example, the granules are applied to provide about 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95 or 100 g/Ha of gibberellic acid or a salt thereof, and useful ranges may be selected between any of these values.

[0085] In some embodiments the granules are applied, for example to pasture, to provide about 10 to about 30 g/Ha and more preferably about 25 to about 30 g/Ha of one or more plant hormones.

[0086] For example, the granules are applied, for example to pasture, to provide about 10 to about 30 g/Ha and more preferably about 25 to about 30 g/Ha of gibberellic acid or a salt thereof.

[0087] In a specifically contemplated embodiment, the granules comprise not more than about 0.3% w/w plant hormone, and are applied to the plant or locus at a rate of at least about 10 kg granule per hectare. For example, the granules comprise about 0.3% w/w plant hormone, and are applied to the plant or locus at a rate of at least about 20 kg granule per hectare. In another example, the granules comprise about 0.15% w/w plant hormone, and are applied to the plant or locus at a rate of at least about 20 kg granule per hectare.

[0088] For example, the granules are applied to the plant or locus at a rate of about 10 g/ha gibberellic acid, for example as a gibberellic acid-coated nitrogen-containing granules applied at a rate to provide 20 kg N per hectare. In another specifically contemplated example, the granules are applied to the plant or locus at a rate of about 20 g/ha gibberellic acid, for example as a gibberellic acid-coated nitrogen-containing granules applied at a rate to provide 20 kg N per hectare. In another example, the granules are applied to the plant or locus at a rate of about 30 g/ha gibberellic acid, for example as a gibberellic acid-coated nitrogen-containing granules applied at a rate to provide 20 kg N per hectare. In another example, the granules are applied to the plant or locus at a rate of about 20g/ha gibberellic acid, for example as a gibberellic acid-coated urea granules applied at a rate to provide 50 kg N per hectare.

[0089] In one embodiment, the granules increase plant growth, such as pasture growth, or to increase plant yield, such as pasture yield.

[0090] In one embodiment, the granules increase pasture dry matter production by at least about 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95 or 100%, and useful ranges may be selected between any of these values.

[0091] In some embodiments, the granules increase pasture dry matter production by at least about 15% to about 50% and more preferably about 15% to about 20%.

[0092] In one embodiment the granules are applied before application of irrigation water or before a period of forecast rainfall.

[0093] It is intended that reference to a range of numbers disclosed herein (for example, 1 to 10) also incorporates reference to all rational numbers within that range (for example, 1, 1.1, 2, 3, 3.9, 4, 5, 6, 6.5, 7, 8, 9 and 10) and also any range of rational numbers within that range (for example, 2 to 8, 1.5 to 5.5 and 3.1 to 4.7).

[0094] This invention may also be said broadly to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, and any or all combinations of any two or more of said parts, elements or features, and where specific integers are mentioned herein which have known equivalents in the art to which this invention relates, such known equivalents are deemed to be incorporated herein as if individually set forth.

[0095] In this specification, where reference has been made to external sources of information, including patent specifications and other documents, this is generally for the purpose of providing a context for discussing the features of the present invention. Unless stated otherwise, reference to such sources of information is not to be construed, in any jurisdiction, as an admission that such sources of information are prior art or form part of the common general knowledge in the art.

[0096] The term "comprising" as used in this specification means "consisting at least in part of". When interpreting statements in this specification which include that term, the features, prefaced by that term in each statement, all need to be present but other features can also be present. Related terms such as "comprise" and "comprised" are to be interpreted in the same manner.

DETAILED DESCRIPTION OF THE INVENTION

[0097] The present invention relates to a fertiliser composition and its use. The fertiliser composition comprises granules, each granule comprising one or more plant hormones, such as gibberellic acid or a salt thereof, one or more polymeric binders, such as polyvinyl alcohol, and optionally one or more carriers and/or one or more additional agents.

[0098] The present invention provides for the application of granules, for example to the soil, enabling the advantages of solid phase application while being as effective as liquid application to the foliage of plants. The application of a granule comprising plant hormone and one or more polymeric binders performs as well as liquid, particularly foliar, application of the plant hormone, while providing benefit in terms of ease of application.

1. Substrate core

[0099] The substrate core forms a core for the addition of a plant hormone as a coating to at least partially coat the substrate core.

[0100] The substrate core can be formed by various compounds to form the basis of the granule to which the plant hormone is added.

[0101] For example, the substrate core can be formed from the group comprising a clay granule, a silicate mineral, an aluminosilicate mineral, for example, zeolite, diatomaceous earth or perlite, vermiculite, a seed, for example, a vegetable seed, a fertiliser granule, or a combination of any two or more thereof. In various embodiments the substrate may comprise a seed, for example an angiosperm, vegetable, legume, cereal or conifer seed. In various embodiments the seed comprises a spinach, carrot, onion, soybean, lucerne, plantain, brassica, maize rye grass, canola or clover seed. In various embodiments the substrate may comprise wheat, barley, bran, maize, rye, rice, sorghum, millet, oats, forage brassica, canola or triticale, or a combination of any two or more thereof. In various embodiments the substrate may comprise a granule comprising a fertiliser, for example, a granule of urea, superphosphate, monoammonium phosphate (MAP), diammonium phosphate (DAP, single superphosphate (SSP), triple superphosphate (TSP), calcium ammonium nitrate (CAN) or muriate of potash (MOP).

[0102] The substrate core can include other active ingredients such as a nitrification inhibitor (e.g. DIDIN). This is discussed further below.

2. Polymeric binder

[0103] Binders promote the ability of the compositions of the invention to adhere to surfaces, and/or the ability of the components of the granules of the invention to adhere to one another during preparation.

[0104] Examples of polymeric binders polymeric binders may be a polyhydroxyl compound, a polymer or copolymer of a C_1–C_6 alkyl substituted with one or more groups selected from the group comprising lactams, preferably γ-lactam, or 2-pyrollidone, or a latex. In various embodiments the polyhydroxyl compound may comprise at least 2, 3, 4, 5, 10, 20, 50, 100, 200, 300, 400, 500, 750, 800, 1,000, 1,200, about 1,500, about 2,000, about 3,000, about 4,000 or at least about 5,000 hydroxyl groups. In various embodiments the polymeric compound may have an average molecular weight of about 5, 10, 20, 22.5, 24.5, 25, 30, 40, 50, 75, 80, 90, 100, 118, 120, 125, 126, 130, 140, 150, 200, 250, 300 or about 350 kDa, In various embodiments the polyhydroxyl compound may be selected from the group comprising a polyvinyl alcohol, a polyethylene oxide, methyl cellulose, a polyvinyl alcohol-polyethylene glycol co-polymer (e.g. Kollicoat® Protect), gum Arabic or a starch. In a particularly preferred embodiment the polyhydroxyl compound is a polyvinyl alcohol. In one embodiment the polyhydroxyl compound may be a polymer or copolymer Of (1) a C_2–C_6 hydroxyalkyl, or (2) a C_2–C_{10} hydroxyalkyl, optionally substituted with acyl and/or optionally comprising an ether moiety, for example, methacrylic acid-ethyl acrylate copolymer (Kollicoat® MAE100). In various embodiments the polyhydroxyl compound may have a degree of hydrolysis of at least about 80, 82.5, 85, 87.5, 90, 92.5, 95 or 98 mol. In various embodiments the polymeric binder may be a polymer or copolymer of a C_1–C_6 alkyl substituted with one or more groups selected from the group comprising lactams, preferably γ-lactam, or 2-pyrollidone. In one embodiment the polymeric binder may be polyvinylpyrrolidone. In various embodiments the polymeric binder may be selected from the group comprising copolymers of vinyl pyrrolidone, and vinyl acetate, poly (methyl vinyl ether), maleic anhydride copolymers, free acids of the copolymer of methyl vinyl ether and maleic anhydride, vinyl pyrrolidone/styrene copolymers, vinyl acetate/butyl acrylate copolymers, vinyl acetate homopolymers, acrylic copolymers, styrene/acrylic ester copolymers, vinyl acetate/ethylene copolymers and polyvinyl acetate, or a combination of any two or more thereof. In one embodiment the polymeric binder may be a latex polymer, for example, EC 23009.

[0105] In one embodiment the polymer is a short chain polymer. For example, having about 7,000, 7500, 8,000, 8500, 9,000, 9500 or 10,,000 units, and useful ranges may be selected between any of these values, (for example, about 7,000 to about 10,000, about 7,000 to about 9,000, about 7,000 to about 8,000, about 7,500 to about 10,000, about 7,500 to about 9,500, about 7,500 to about 8,000, about 8,000 to about 10,000, about 8,000 to about 9,500, about 8,000 to about 8500 or about 9,000 to about 10,000 units).

[0106] In one embodiment the polymer is a long chain polymer. For example, having about 80,000, 90,000, 100,000, 110,000, 120,000, 130,000, 140,000 or 150,000 units, and useful ranges may be selected between any of these values, (for example, about 80,000 to about 150,000, about 80,000 to about 140,000, about 80,000 to about 120,000, about 80,000 to about 100,000, about 90,000 to about 150,000, about 90,000 to about 140,000, about 90,000 to about 130,000, about 90,000 to about 100,000, about 100,000 to about 150,000, about 100,000 to about 130,000, about 100,000 to about 120,000, about 110,000 to about 150,000, about 110,000 to about 140,000, about 110,000 to about 130,000, about 120,000 to about 150,000, about 120,000 to about 140,000, about 130,000 to about 150,000 units).

[0107] In one embodiment the polymeric binder is a starch such as potato starch or a pregelatinised starch.

[0108] The polymeric binder is present at an amount of about 0.025, 0.03, 0.035, 0.04, 0.045, 0.05, 0.055, 0.06, 0.065, 0.07, 0.075, 0.08, 0.085, 0.09, 0.95 or 1 g/kg of substrate core, and useful ranges may be selected between any of these values, (for example, 0.035 to about 0.1, about 0.035 to about 0.09, about 0.035 to about 0.065. 0.035 to about 0.06, about 0.035 to about 0.055, about 0.035 to about 0.05, about 0.04 to about 0.1, about 0.04 to about 0.8, about 0.04 to about 0.06, about 0.04 to about 0.05, about 0.045 to about 0.1, about 0.045 to about 0.085, about 0.045 to about 0.075, about 0.045 to about 0.06, about 0.045 to about 0.05, about 0.05 to about 0.1, about 0.05 to about 0.09, about 0.05 to about 0.07, about 0.06 to about 0.1, about 0.06 to about 0.08, about 0.065 to about 0.1, about 0.065 to about 0.08, about 0.07 to about 0.1, about 0.07 to about 0.09, about 0.08 to about 0.1 g/kg of substrate core).

3. Plant hormones

[0109] Plant hormones are substances which modulate cellular functions and regulate growth. It is generally accepted that there are five classes of plant hormones:

Auxins, such as indole-3-acetic acid (IAA), 1-Naphthaleneacetic acid (NAA), and indole-3-butyric acid (IBA); Abscisic acid (ABA); Cytokinins, such as zeatin; Ethylene; and Gibberellins. Other exemplary plant hormones have been reported, including Brassinosteroids, such as brassinolide, Salicylic acid, Jasmonates, Plant peptide hormones, Polyamines, Nitric oxide, and Strigolactones.

[0110] These plant hormones, including those which have been utilised in agricultural, including horticultural, applications, are suitable for use in the present invention.

[0111] Gibberellic acid (also known as Gibberellin A3, GA, and GA_3) is a hormone found in plants and has the chemical formula is $C_{19}H_{22}O_6$. When purified gibberellic acid is a white to pale-yellow solid. The gibberellic acid can also be present in an ammonium or potassium form.

[0112] Gibberellic acid promotes growth and elongation of cells and stimulates the cells of germinating seeds to produce mRNA molecules that code for hydrolytic enzymes. Since GA regulates growth, applications of low concentrations can have an effect while too much can lead to opposite effects.

[0113] Gibberellic acid for use in the present invention can be as a single form or a mixture of forms. For example, the Gibberellic acid may be present as a mixture of GA_4 and GA_7.

4. Granules

[0114] As used herein the term "granule" includes granules, prills, pellets, small particles and grains, and has a mean particle size of at least 200, 300, 400, 500, 600, 700, 800, 900 or 1,000 µm.

[0115] The fertiliser composition of the present invention comprises granules, the granules comprising one or more plant hormones, such as gibberellic acid or a salt thereof, one or more polymeric binders, and optionally one or more carriers and/or one or more additional agents.

[0116] It should be appreciated that the granule can comprise the one or more plant hormones, such as gibberellic acid, and one or more polymeric binders as

- a coating of plant hormone about a granule that contains one or more polymeric binders,

- a granule comprising a homogenous mix of one or more carriers and/or one or more additional agents and plant hormone, and one or more polymeric binders, or
- a granule comprising one or more polymeric binders, plant hormone in a carrier, encapsulated or coated by one or more carriers and/or one or more additional agents.

[0117] The granules of the present invention contain about 0.01, 0.05, 0.1, 0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, 0.95, 1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9 or 3 mg of one or more plant hormones, such as gibberellic acid per gram of granule, and useful ranges may be selected between any of these values (for example, from about 0.01 to about 3, from about 0.01 to about 2.1, from about 0.01 to about 1.5, from about 0.01 to about 1.0, from about 0.01 to about 0.3, from about 0.05 to about 3, from about 0.05 to about 2.2, from about 0.05 to about 1.9, from about 0.05 to about 1.0, from about 0.05 to about 0.8, from about 0.05 to about 0.1, from about 0.2 to about 3, from about 0.2 to about 2.4, from about 0.2 to about 1.6, from about 0.2 to about 1.0, from about 0.2 to about 0.8, from about 0.75 to about 3, from about 0.75 to about 2.4, from about 0.75 to about 2, from about 0.75 to about 1.2, from about 1.1 to about 3, from about 1.1 to about 2.6, from about 1.1 to about 2.0, from about 1.1 to about 1.8, from about 1.1 to about 1.4, from about 1.7 to about 3, from about 1.7 to about 2.8, from about 1.7 to about 2.6, from about 1.7 to about 2.0, from about 2.0 to about 3.0, from about 2.0 to about 2.8 or from about 2.0 to about 2.2 mg of one or more plant hormones, such as gibberellic acid, per gram of granule).

[0118] In one embodiment, when applied as a coating the one or more plant hormones, such as gibberellic acid, partially coats the surface of the granule, or coats all of the granule, or any amount in between, for example a majority or substantially all of the granule.

[0119] The granules of the present invention a mean diameter of about 500, 600, 700, 800, 900, 1,000, 1,200, 1,400, 1,600, 1,800, 2,000, 2,200, 2,400, 2,600, 2,800, 3,000, 3,200, 3,400, 3,600, 3,800, 4,000, 4,200, 4,400, 4,600, 4,800 or 5,000 μm, and useful ranges may be selected between any of these values (for example, from about 500 to about 5,000, from about 500 to about 4,200, from about 500 to about 3,600, from about 500 to about 2,200, from about 500 to about 1,000, from about 700 to about 5,000, from about 700 to about 4400, from about 700 to about 3,800, from about 700 to

about 1,600, from about 800 to about 5,000, from about 800 to about 4,800, from about 800 to about 3,400, from about 800 to about 3,000, from about 800 to about 1,200, from about 1,400 to about 5,000, from about 1,400 to about 4,400, from about 1,400 to about 3,000, from about 1,400 to about 2,600, from about 1,400 to about 2,000, from about 2,000 to about 5,000, from about 2,000 to about 4,800, from about 2,000 to about 4,200, from about 2,000 to about 3,800, from about 2,000 to about 3,400, from about 2,000 to about 3,200, from about 2,000 to about 3,000, from about 2,000 to about 2,800, from about 2,600 to about 5,000, from about 2,600 to about 3,400, from about 2,600 to about 3,000, from about 3,000 to about 5,000, from about 3,000 to about 4,400, from about 3,000 to about 4000, from about 3,600 to about 5,000, from about 3,600 to about 4,600, from about 3600 to about 4,000, from about 4,200 to about 5,000 or from about 4,200 to about 4,800 μm).

[0120] A specifically contemplated mean diameter range of the granules is about 2,000 to about 4,000 μm.

[0121] In various embodiments, the granules of the present invention have a particle size distribution whereby at least 90% of the granules have a diameter of from 1 mm to 5 mm. In one embodiment, the invention relates to a population of granules wherein at least 90% of the granules have a diameter within 1 mm of the mean diameter of the population.

[0122] In various embodiments the granules of the present invention have a bulk density of from about 0.5 g/cm^3 to about 1.5 g/cm^3. For example, the granules of the present invention have a bulk density of from about 0.6 g/cm^3 to about 1.5 g/cm^3, from about 0.7 g/cm^3 to about 1.5 g/cm^3, from about 0.8 g/cm^3 to about 1.5 g/cm^3, from about 0.9 g/cm^3 to about 1.5 g/cm^3, from about 1 g/cm^3 to about 1.5 g/cm^3, from about 1.1 g/cm^3 to about 1.5 g/cm^3, from about 1.2 g/cm^3 to about 1.5 g/cm^3, or from about 1.3 g/cm^3 to about 1.5 g/cm^3.

[0123] In another example, the granules of the present invention have a bulk density of from about 0.5 g/cm^3 to about 1.4 g/cm^3, from about 0.5 g/cm^3 to about 1.3 g/cm^3, from about 0.5 g/cm^3 to about 1.2 g/cm^3, from about 0.5 g/cm^3 to about 1.1 g/cm^3, from about 0.5 g/cm^3 to about 1 g/cm^3, from about 0.5 g/cm^3 to about 0.9 g/cm^3, or from about 0.5 g/cm^3 to about 0.8 g/cm^3.

[0124] In still another example, the granules of the present invention have a bulk density of from about 0.7 g/cm^3 to about 1.4 g/cm^3, from about 0.8 g/cm^3 to about 1.3 g/cm^3, from about 0.9 g/cm^3 to about 1.2 g/cm^3, from about 0.9 g/cm^3 to about 1.1 g/cm^3, or have a bulk density of about 1 g/cm^3.

[0125] In one embodiment, the compositions of the invention comprise two or more populations of granules, wherein the two or more populations differ in one or more physical or compositional characteristic.

[0126] For example, in one embodiment, the composition of the invention comprises two or more populations of granules which differ in the plant hormone or mix of plant hormones, or in the one or more additional agents, present in each population of granules comprising the composition. In another embodiment, the composition of the invention comprises two or more populations of granules which differ in their mean diameter or bulk density, for example to allow different rates of uptake or release following distribution.

Agricultural carriers and additional agents

[0127] In various embodiments, the compositions or granules of the invention comprise one or more additional agents, such as one or more fertilizers, one or more trace elements, one or more nitrification inhibitors, one or more urease inhibitors, one or more growth stimulants, one or more microbes, or one or more other agriculturally acceptable agents.

[0128] Exemplary fertilizers include urea and other nitrogen-providing substances, super phosphates (whether single super phosphate) ("SSP"), double super phosphate ("DSP") or triple super phosphate ("TSP"), or mixtures and derivatives thereof.

[0129] Nitrification inhibitors are substances that slow or stop the conversion of soil ammonium to nitrate. Exemplary nitrification inhibitors include N-2,5-dichlorophenyl succinamic acid, 2-chloro-6-trichloromethyl pyridine ("Nitrapyrin"), dicyandiamide ("DCD or "DCDIN", which is HN=C(NH2)-NH-CN), zinc ethylene-bis-dithiocarbamate, 2,4,6-trichloroaniline, pentachlorophenol, thio-urea, ATS (ammonium thiosulphate), and pyrazole derivatives, such as DMPP (3,4 dimethylpyrazol phosphate), 3-MP (3-methylpyrazole) and/or DMP (3,4-dimethylpyrazole), including water soluble forms of pyrazole derivatives.

[0130] In various embodiments, the compositions or granules of the invention comprise from about 1% w/w to about 35% w/w one or more nitrification inhibitor.

[0131] Urease inhibitors, typically used to inhibit the activity of soil urease, can be classified according to their structure or function, and representative classes include sulphydryl reagents, hydroxamates, agricultural crop protection chemicals, and structural analogues of urea and related compounds, such as the organophosphorus inhibitors, particularly the phosphorodiamidates, the phosphorotriamides and the triophosphorotriamides.

[0132] Exemplary urease inhibitors suitable for use in the present invention include N-(n-butyl) thiophosphoric triamide (NBTPT or NBPT), cyclohexylphosphoric triamide (CHPT), cyclohexyl thiophosphoric triamide (CHTPT), cyclohexyl phosphric triamide (CNPT), phenyl phosphorodiamidate (PPDA), N-(n-butyl) phosphoric triamide (BNPO or NBPTO), thiophoshoryl triamide (TPT), phenyl phosphorodiamidate (PPD/PPDA), phosphoric triamide (PT), hydroquinone (HQ), P-benzoquinone, hexaamidocyclotriphosphazene (HACTP), thiophyridines, thiophyrimidines, thiophyridine-Noxides, NN-dihalo-2-imidazolidinone, and N-halo-2-oxazolidinone.

[0133] In various embodiments, the compositions or granules of the invention comprise at least one agriculturally acceptable carrier. Carriers useful herein include any substance typically used to formulate agricultural composition.

[0134] In one embodiment the agriculturally acceptable carrier is selected from the group comprising fillers, solvents, excipients, surfactants, suspending agents, antifoaming agents, dispersants, wetting agents, drift reducing agents, auxiliaries, adjuvants or a mixture thereof.

[0135] For example, the at least one carrier is selected from the group consisting of a filler stimulant, an anti-caking agent, a wetting agent, an emulsifier, and an antioxidant, for example said composition comprises at least one of each of a filler stimulant, an anti-caking agent, a wetting agent, an emulsifier, and an antioxidant.

[0136] In one embodiment, said filler stimulant is a carbohydrate source, such as a disaccharide including, for example, sucrose, an oligosaccharide including for example starch, fructose, glucose, mannitol or dextrose, said anti-caking agent is selected from talc, silicon dioxide, calcium silicate, or kaolin clay, said wetting agent is skimmed milk powder, or any commercially available product such as Duwett™, Latron™, said

emulsifier is a soy-based emulsifier such as lecithin or a vegetable-based emulsifier such as monodiglyceride, and said antioxidant is sodium glutamate or citric acid or potassium sorbate or an alcohol.

[0137] In one embodiment solid carriers include but are not limited to mineral earths such as silicic acids, silica gels, silicates, talc, kaolin, attapulgus clay, limestone, lime, chalk, bole, loess, clay, bentonite, dolomite, diatomaceous earth, aluminas calcium sulfate, magnesium sulfate, magnesium oxide, peat, humates, ground plastics, fertilizers such as ammonium sulfate, ammonium phosphate, ammonium nitrate, and ureas, and vegetable products such as grain meals, bark meal, wood meal, and nutshell meal, cellulosic powders, seaweed powders, peat, talc, carbohydrates such as mono-saccharides and di-saccharides, starch extracted from corn or potato or tapioca, chemically or physically altered corn starch and the like. As solid carriers for granules the following are suitable: crushed or fractionated natural rocks such as calcite, marble, pumice, sepiolite and dolomite; synthetic granules of inorganic or organic meals; granules of organic material such as sawdust, coconut shells, corn cobs, corn husks or tobacco stalks; kieselguhr, tricalcium phosphate, powdered cork, or absorbent carbon black; water soluble polymers, resins, waxes; or solid fertilizers. Such solid compositions may, if desired, contain one or more compatible wetting, dispersing, emulsifying or colouring agents which, when solid, may also serve as a diluent.

[0138] In various embodiments, the carrier used during preparation of the granules or compositions of the invention is a liquid, for example, water; alcohols, particularly butanol or glycol, as well as their ethers or esters, particularly methylglycol acetate; ketones, particularly acetone, cyclohexanone, methylethyl ketone, methylisobutylketone, or isophorone; petroleum fractions such as paraffinic or aromatic hydrocarbons, particularly xylenes or alkyl naphthalenes; mineral or vegetable oils; aliphatic chlorinated hydrocarbons, particularly trichloroethane or methylene chloride; aromatic chlorinated hydrocarbons, particularly chlorobenzenes; water-soluble or strongly polar solvents such as dimethylformamide, dimethyl sulfoxide, or N-methylpyrrolidone; liquefied gases; or the like or a mixture thereof.

[0139] In one embodiment surfactants include nonionic surfactants, anionic surfactants, cationic surfactants and/or amphoteric surfactants. Said surfactants are typically used during preparation of the granules and compositions of the invention.

[0140] In various embodiments wetting agents are used in the methods of preparation of the granules and compositions of the invention. Examples of wetting agents include but are not limited to salts of polyacrylic acids, salts of lignosulfonic acids, salts of phenolsulfonic or naphthalenesulfonic acids, polycondensates of ethylene oxide with fatty alcohols or fatty acids or fatty esters or fatty amines, substituted phenols (particularly alkylphenols or arylphenols), salts of sulfosuccinic acid esters, taurine derivatives (particularly alkyltaurates), phosphoric esters of alcohols or of polycondensates of ethylene oxide with phenols, esters of fatty acids with polyols, or sulfate, sulfonate or phosphate functional derivatives of the above compounds.

[0141] As described herein, the compositions or granules of the present invention are in various embodiments formulated with, and in other embodiments used in combination with one or more other agricultural agents, including pesticides, insecticides, acaracides, additional fungicides, bactericides, herbicides, antibiotics, antiphytopathogenic microbials, nematicides, rodenticides, entomopathogens, pheromones, attractants, plant growth regulators, plant hormones, insect growth regulators, chemosterilants, phytopathogenic microbial pest control agents, repellents, viruses, phagostimulents, plant nutrients, plant fertilisers and biological controls.

[0142] When used in combination with other agricultural agents the administration of the two agents may be separate, simultaneous or sequential. Specific examples of these agricultural agents are known to those skilled in the art, and many are readily commercially available.

[0143] Examples of plant nutrients include but are not limited to nitrogen, magnesium, calcium, boron, potassium, copper, iron, phosphorus, sulphate, manganese, molybdenum, cobalt, boron, copper, silicon, selenium, nickel, aluminium, chromium and zinc.

[0144] Examples of antibiotics include but are not limited to oxytetracyline and streptomycin.

[0145] Examples of fungicides include but are not limited to the following classes of fungicides: carboxamides, benzimidazoles, triazoles, hydroxypyridines, dicarboxamides, phenylamides, thiadiazoles, carbamates, cyano-oximes, cinnamic acid derivatives, morpholines, imidazoles, beta-methoxy acrylates and pyridines/pyrimidines.

[0146] Further examples of fungicides include but are not limited to natural fungicides, organic fungicides, sulphur-based fungicides, copper/calcium fungicides and elicitors of plant host defences.

[0147] Examples of natural fungicides include but are not limited to whole milk, whey, fatty acids or esterified fatty acids.

[0148] Examples of organic fungicides include but are not limited to any fungicide which passes an organic certification standard such as biocontrol agents, natural products, elicitors (some of may also be classed as natural products), and sulphur and copper fungicides (limited to restricted use).

[0149] An example of a sulphur-based fungicide is Kumulus™ DF (BASF, Germany). An example of a copper fungicide is Kocide® 2000 DF (Griffin Corporation, USA).

[0150] Examples of elicitors include but are not limited to chitosan, Bion™, BABA (DL-3-amino-n-butanoic acid, β-aminobutyric acid), salicylic acid or its derivatives (e.g. Actigard, Syngenta) and Milsana™ (Western Farm Service, Inc., USA).

[0151] In some embodiments non-organic fungicides may be employed. Examples of non-organic fungicides include but are not limited to Bravo™ (for control of powdery mildew on cucurbits); Supershield™ (Yates, NZ) (for control of Botrytis and powdery mildew on roses); Topas® 200EW (for control of PM on grapes and cucurbits); Flint™ (for control of powdery mildew on apples and cucurbits); Amistar® WG (for control of rust and powdery mildew on cereals); and Captan™, Dithane™, Euparen™, Rovral™, Scala™, Shirlan™, Switch™ and Teldor™ (for control of Botrytis on grapes).

[0152] Examples of pesticides include but are not limited to azoxystrobin, bitertanol, carboxin, Cu_2O, copper hydroxide, copper sulphate, cymoxanil, cyproconazole, cyprodinil, dichlofluamid, difenoconazole, diniconazole, epoxiconazole, fenpiclonil, fludioxonil, fluquiconazole, flusilazole, flutriafol, furalaxyl, guazatin, hexaconazole, hymexazol, imazalil, imibenconazole, ipconazole, kresoxim-methyl, lime sulphur, mancozeb, metalaxyl, R-metalaxyl, metconazole, oxadixyl, pefurazoate, penconazole, pencycuron, prochloraz, propiconazole, pyroquilone, SSF-109, spiroxamin, tebuconazole, thiabendazole, tolifluamid, triazoxide, triadimefon, triadimenol, triflumizole, triticonazole and uniconazole.

[0153] An example of a biological control agent other than a bacterial strain of the present invention is the BotryZen™ biological control agent comprising *Ulocladium oudemansii*.

[0154] Specifically contemplated embodiments of compositions and granules of the invention comprise trace elements, such as but not limited to manganese, magnesium, zinc, potassium, sodium, cobalt, sulphur (which may conveniently be provided as a sulphate), molybdate, copper, and iron (which may conveniently be provided as a chelate); carbohydrates, such as but not limited to molasses; one or more gums, such as but not limited to guar gum, xanthan gum, locust bean gum, cassia gum, konjac flour, beta-glucan, tara gum, gum arabic, gellan gum, carboxymethylcellulose, methylcellulose, hydroxypropyl methylcellulose, tragacanth gum, karaya gum, gum acacia, chitosan, arabinoglactins, alginate, pectin, carrageenan, or psyllium; acids, particularly weak acids such as citric acid, sorbic acid, sorbate and other ingredients, such as one or more algae, seaweed, or extracts thereof.

[0155] An exemplary granule of the invention comprises a carrier core coated in a binder, such as a polyvinyl alcohol or starch, to which is applied plant hormone, such as gibberellic acid.

5. Manufacturing method

[0156] The granules of the present invention can be formed by granulation and/or spray coating techniques.

[0157] The one or more plant hormones, such as gibberellic acid, is coated onto the granule. It should be appreciated that the coating could be in a wet or dry form. For example, if applied in wet form the one or more plant hormones, such as gibberellic acid, in one embodiment consists as a mixture of one or more plant hormones in a carrier. The carrier can be, for example, water, an alcohol, or an organic solvent. Examples of possible organic solvents include primary, secondary and tertiary alcohols from C_1 to C_{10}, such as propanol and iso-propanol. The mixture of gibberellic acid in the carrier may be present as a solution or slurry. In one embodiment the gibberellic acid is dissolved in the carrier. The gibberellic acid is then sprayed onto, incorporated into or impregnated onto the granule or granules.

[0158] With wet granulation, granules are formed by addition of a granulation liquid, such as water, ethanol and isopropanol or any volatile solvent that is readily

removed by drying, onto a bed of powdered carrier. The powdered bed is agitated by an impeller, screws or air stream. The agitation imparted by the impeller, screws or air stream combined with wetting of the components by the granulation liquid results in aggregation of the powder particles of carrier to produce wet granules that are then dried.

[0159] Dry granulation is used to form granules without using a liquid solution, by compacting and densifying the powders. Powder particles are aggregated under high pressure using, for example, a tableting machine for batch production or a roller compactor for continuous production.

[0160] When applied in a dry form the one or more plant hormones, such as gibberellic acid, may be in the form of a dry powder. The one or more plant hormones, such as gibberellic acid, when applied to the granule, will form a particulate coating about the granule.

[0161] In another embodiment one or more carriers and/or one or more additional agents, one or more binders, and one or more plant hormones, such as gibberellic acid, are mixed together as a slurry or dry powder. For example, the one or more carriers and/or one or more additional agents is prepared as a slurry into which the one or more plant hormones, such as gibberellic acid, is mixed, or the one or more plant hormones is prepared as a slurry into which the one or more carriers and/or one or more additional agents is mixed. Alternately, dry forms of the one or more plant hormones and one or more carriers and/or one or more additional agents are mixed together.

[0162] In one embodiment the one or more plant hormones is coated onto a granule which itself is coated with the one or more polymeric binders.

[0163] In an alternate embodiment the polymeric binder may be mixed with the plant hormone and the mixture coated onto the granule.

[0164] When mixed in a slurry or dry form the one or more carriers and/or one or more additional agents may be pressed formed into a granule, for example as a pressed pellet. Exemplary pressing conditions for pellet production are 5 tonne on 1 cm^2 for 30 sec, although those skilled in the art would appreciate that other pelleting conditions can be utilised. The granule may then be coated with the polymeric binder and then the plant hormone.

[0165] When mixed in a slurry or dry form the one or more carriers and/or one or more additional agents, one or more polymeric binders and one or more plant hormones, such as gibberellic acid, may be pressed formed into a granule, for example as a pressed pellet. Exemplary pressing conditions for pellet production are 5 tonne on 1 cm^2 for 30 sec, although those skilled in the art would appreciate that other pelleting conditions can be utilised.

[0166] An alternate method is the production in prilled form of one or more polymeric binders, one or more carriers and/or one or more additional agents that is subsequently coated in one or more plant hormones, or of a mixture of one or more carriers and/or one or more additional agents and one or more plant hormones, optionally together with one or more additional agents, carriers or the like.

[0167] When supplied as a surface preparation after production of the granule or prill (which may optionally contain urea), the one or more plant hormones, such as gibberellic acid, may be sprayed as a salt, for example a gibberellic acid salt (e.g. ammonium or potassium salt).

[0168] When urea is included, the urea incorporated into the granule is selected from any source of urea. For example, urea phosphate, urea sulphur or urea potash.

6. Application to soil

[0169] In accordance with the invention, the granules are spread onto a plant or a locus in which a plant is or is to be planted, such as, for example, a pasture. The granules may be spread by spraying, blowing, spinning or pneumatic application the granules such that the granules cover 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95 or 100% of the plants or locus, such as the pasture.

[0170] In one embodiment the granules are applied, for example to pasture, to provide about 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95 or 100 g/Ha of one or more plant hormones, such as gibberellic acid or a salt thereof, and useful ranges may be selected between any of these values (for example, about 5 to about 100, about 5 to about 90, about 5 to about 75, about 5 to about 60, about 5 to about 55, about 5 to about 40, about 5 to about 30, about 5 to about 20, about 10 to about 95, about 10 to about 90, about 10 to about 80, about 10 to about 70, about 10 to about 60, about 10 to about 55, about 10 to about 40, about 10 to about 30, about 10 to about 20, about 15 to about 90, about 15 to about 80, about 15 to about 60, about 15 to

about 50, about 20 to about 100, about 20 to about 90, about 20 to about 85, about 20 to about 80, about 20 to about 75, about 20 to about 60, about 20 to about 55, about 20 to about 40, about 25 to about 100, about 25 to about 80, about 25 to about 75, about 25 to about 60, about 25 to about 55, about 25 to about 40, about 30 to about 100, about 30 to about 90, about 30 to about 80, about 30 to about 70, about 30 to about 60, about 30 to about 50, about 40 to about 100, about 40 to about 95, about 40 to about 85, about 40 to about 65, about 40 to about 60, about 40 to about 55, about 50 to about 100, about 50 to about 80, about 50 to about 70, about 50 to about 60, about 60 to about 100, about 60 to about 85, about 60 to about 75, about 75 to about 100, about 75 to about 80, about 85 to about 100, about 85 to about 90 or about 90 to about 100 g/Ha).

[0171] In one embodiment, the granules increase pasture dry matter production by at least about 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95 or 100%, and useful ranges may be selected between any of these values (for example, about 10 to about 95, about 10 to about 90, about 10 to about 80, about 10 to about 70, about 10 to about 60, about 10 to about 55, about 10 to about 40, about 10 to about 30, about 10 to about 20, about 15 to about 90, about 15 to about 80, about 15 to about 60, about 15 to about 50, about 20 to about 100, about 20 to about 90, about 20 to about 85, about 20 to about 80, about 20 to about 75, about 20 to about 60, about 20 to about 55, about 20 to about 40, about 25 to about 100, about 25 to about 80, about 25 to about 75, about 25 to about 60, about 25 to about 55, about 25 to about 40, about 30 to about 100, about 30 to about 90, about 30 to about 80, about 30 to about 70, about 30 to about 60, about 30 to about 50, about 40 to about 100, about 40 to about 95, about 40 to about 85, about 40 to about 65, about 40 to about 60, about 40 to about 55, about 50 to about 100, about 50 to about 80, about 50 to about 70, about 50 to about 60, about 60 to about 100, about 60 to about 85, about 60 to about 75, about 75 to about 100, about 75 to about 80, about 85 to about 100, about 85 to about 90 or about 90 to about 100%).

[00100] The granular fertiliser can be spread onto soil, pasture, crops, arable land in accordance with known application methods. For example, the granular fertiliser can be loaded into a vehicle mounted hopper and distributed onto the soil. Spraying, blowing and spinning are commonly used methods of distributing granular compositions, and spinner trucks and blower trucks, as are commonly used in the art, are convenient vehicles to distribute the compositions and granules of the invention. Application by side

dressing could also be carried out. It should be appreciated that aerial spraying could also be used. In one embodiment the exemplary method of applying the granules or compositions of the invention is to spray or distribute the granules by handgun or commercial airblast, for example using air-drilling or other pneumatic techniques.

[0172] The granules could also be applied to the soil by subsurface application. Standard processes could be used as known in the art, such as drilling and air-drilling.

[0173] In one embodiment application of irrigation water follows application of the plant hormone-coated granule to the soil. It should be appreciated that rain subsequent to the granular fertiliser soil application may also be sufficient to disperse the granular fertiliser into the soil.

7. Use of the fertiliser granule

[0174] The granules of the present invention are suitable for providing fertilizer to any plants, or to any locus in which a plant is or is to be grown. Application to agriculturally important plants, such as pasture, horticultural plants, flowers, cropping plants, such as vegetables including brassicas, cucubits, and legumes,cereals, fruits, etc, are particularly contemplated.

[0175] Advantages of the fertiliser granule of the present invention include

- ease of manufacture
- ease of handling, and
- ease of application.

[0176] In relation to the ease of manufacture, the manufacture of granules produces less dust compared to the manufacture of a powder.

[0177] The applicants believe, without wishing to be bound by any theory, that in comparison to a liquid formulation, the shelf life of a granule is improved, potentially around twice as long compared to a liquid formulation. Additionally, in terms of application, there is an advantage of granule application over liquid, at least in part because there is no need to transport water or large volumes of liquid.

[0178] The invention has particular application to plants and plant products, either pre- or post-harvest. For example, the composition of the invention may be applied to stored products of the type listed above including fruits, vegetables, cut flowers and

seeds. Suitable application techniques encompass those identified above, particularly spraying, blowing, spinning or pneumatic application.

[0179] The compositions and granules of the invention can be used to treat or pretreat soils or seeds. The compositions and granules of the invention also find use in plant processing materials such as protective coatings, boxes and wrappers.

[0180] The invention consists in the foregoing and also envisages constructions of which the following gives examples only and in no way limit the scope thereof.

EXAMPLES

[0181] This example was carried out to investigate application of GA applied as a foliar spray or as a solid granule on perennial ryegrass shoot dry matter accumulation.

1. Test groups

[0182] The following test groups were examined.

T1 Control – urea granules applied to the soil surface at 20 kg N/ha.

T2 Foliar spray of GA_3-K (30 g/ha GA3 a.i. with surfactant), with urea granules being applied to the soil surface at 20 kg N/ha.

T3 Foliar spray of GA_3-K (120 g/ha GA3 a.i. with surfactant), as T2 above.

T4 Foliar spray of GA_3-K (480 g/ha GA3 a.i. with surfactant), as T2 above.

T5 GA_3-K dissolved in soil solution (30 g/ha GA_3 a.i., no surfactant), with urea granules being applied to the soil surface at 20 kg N/ha.

T6 Original crystalline GA_3-coated urea granules applied to soil surface (30 g/ha GA_3 a.i.). No surfactant, binder coating being a long chain PVA (about 100,00 units).

T7 As for T6 above, but using GA_3-K instead of GA_3.

T8 GA_3-K coated urea granules applied to soil surface (30 g/ha GA_3 a.i.). Surfactant + new coating with short chain PVA (about 9000 units).

T9 As for T8 above, but with GA_3-K at 60 g/ha GA3 a.i.

T10 As for T8 above, but with GA_3-K at 120 g/ha GA3 a.i.

T11 As for T8 above, but with GA_3-K at 240 g/ha GA3 a.i.

T12 As for T8 above, but with GA_3-K at 480 g/ha GA3 a.i.

T13 Calcium nitrate granules or crystals (20 kg N/ha) applied to soil surface.

T14 As for T13 above, but with calcium nitrate granules or crystals coated with GA_3-K (30 g/ha GA_3 a.i.). Surfactant + coating of short chain PVA.

T15 As for T13 above, but with calcium nitrate granules or crystals coated with GA_3-K (60 g/ha GA_3 active). Surfactant + coating of short chain PVA.

2. Results

[0183] The results are given in Table 1 below.

Table 1: Results of application of T1 to T15 to soil.

Treatment	First harvest (g)	Second harvest (g)	Combined harvests (g)	Increase (%) relative to T1
T1	7.7	7.4	15.1	0
T2	8.2	9.2	17.4	15
T3	9.7	10.1	19.8	31
T4	9.9	10.3	20.1	33
T5	9.1	10.0	19.1	26
T6	8.2	9.4	17.6	17
T7	8.5	9.2	17.7	18
T8	9.0	9.5	18.5	23
T9	9.8	10.3	20.1	33
T10	9.1	8.4	17.5	16
T11	9.6	9.7	19.3	28
T12	9.5	10.2	19.7	30
T13	8.5	7.5	16.0	6
T14	8.3	7.7	16.0	6
T15	8.3	8.0	16.3	8

3. Discussion

[0184] The results demonstrate that high doses of GA_3-K (higher than 30 g a.i. of GA_3 per hectare), applied as both foliar sprays or as "solid" GA_3-K (coated onto urea granules) yield an additional promotion of perennial ryegrass shoot dry matter accumulation, when co-applied with granular urea at 20 kg N per hectare.

[0185] The 120 g.a.i. rate per ha of foliar sprayed GA_3-K caused a ca. 2-fold increase (i.e. compare T2 and T3 against control T1). For the solid GA_3-K, the next lowest rate (60 g a.i. of GA_3 per ha) caused a ca. 1.5-fold increase (i.e. compare T8 and T9

against control T1). Further increases in solid GA_3-K application rates, however, had no significant effect on the accumulation of perennial ryegrass shoot dry matter.

[0186] Thus, where soil moisture was maintained at near field capacity (and no water or N or GA_3-K was lost via drainage from pots due to use of trays), the application of GA_3-K-coated urea granules (60 g a.i. of GA_3 per ha) can increase perennial ryegrass shoot dry matter by ca. 30%.

[0187] The result of foliar sprays of GA_3-K (30 g a.i. of GA_3 per ha) was a 15% increase in shoot dry matter (see T2). In contrast, coated granules of GA_3-K, placed on the soil surface at the same rate gave a 23% increase in shoot dry matter (see T8).

[0188] Application of liquid GA_3-K, solubilized in water without surfactant and applied to pots of perennial ryegrass from the bottom (via a tray and including periods of standing water) induce similar shoot dry matter promotion as applications of foliar sprays or soil-applied "solid" GA_3-K (coated onto granules of urea).

[0189] Application of GA_3-K (at 30 g a.i. of GA_3 per ha without surfactant) dissolved in water and placed into trays (T5) with standing water gave 26% increase in shoot dry matter over two production harvests. In contrast, application of foliar sprays of GA_3-K at the same rate gave only 15% increase in shoot dry matter (T2). Application of solid GA_3-K at the same dose gave either 18% (T7, without surfactant and with long chain PVA) or 23% (T8, with surfactant and short chain PVA) increases.

[0190] Addition of surfactant and a change from coating the urea granules with GA_3-K using long chain PVA, to coating them with GA_3-K using short chain PVA influences perennial ryegrass shoot dry matter accumulation.

[0191] By comparing the increase in ryegrass shoot dry matter accumulation for the two production harvests, i.e. T7 (18%) versus T8 (23%), it is evident that when using surfactant and a short chain PVA, there is an increase in GA_3-K efficacy. Since the T5 treatment (w/o surfactant) gave 26% increase it appears that the increase seen for T8 (relative to T7) is likely due to using a different, short chain PVA coating.

[0192] Substitution of a different N source (calcium nitrate) in lieu of urea, may influence N granule/crystal-coated GA_3-K uptake by perennial ryegrass plant roots. The use of calcium nitrate instead of urea as a source of N gave a slight (6%) increase in ryegrass shoot dry matter accumulation for two production harvests - compare T13 with

T1. However, the coating of calcium nitrate granules/crystals with GA_3-K at 30 or 60 g a.i. of GA_3 per hectare yielded no further significant increases in shoot dry matter accumulation - compare T14 (6%) and T15 (8%) with T13 (6%).

[0193] Where in the foregoing description reference has been made to elements or integers having known equivalents, then such equivalents are included as if they were individually set forth.

[0194] Although the invention has been described by way of example and with reference to particular embodiments, it is to be understood that modifications and/or improvements may be made without departing from the scope or spirit of the invention.

CLAIMS

1. A granule, the granule comprising a substrate core, one or more polymeric binders, and one or more plant hormones coated about the substrate core.

2. A granule of claim 1 comprising In one aspect the invention relates to granules, the granules comprising about 0.025 to about 1 g/kg of substrate core of a polymeric binder present as

i) a first coating on the substrate core (prior to the plant hormone-containing coating),

ii) a mixture with the plant hormone, or

iii) both i) and ii) above.

3. A granule of claim 1 or 2 having

a) a bulk density of from about 0.5 g/cm^3 to about 1.5 g/cm^3, or

b) a mean diameter (weight-based) of from about 1 mm to 5 mm, or

c) a particle size distribution whereby at least 90% of the granules have a diameter of from 1 mm to 5 mm, or

d) a particle size distribution whereby at least 90% of the granules have a diameter within 1 mm of the mean diameter, or

e) a hardness of from about 10 N to about 70 N, or

f) less than about 0.5% w/w plant hormone, or

g) any combination of two or more of (a) to (f) above.

4. A granule of any one of claims 1 to 3 wherein the substrate is selected from the group comprising a clay granule, a silicate mineral, an aluminosilicate mineral, a seed, a fertiliser, and a combination thereof.

5. A granule of claim 4 wherein the substrate core is urea.

6. A granule of any one of claims 1 to 5 wherein the substrate core includes a nitrification inhibitor.

7. A granule of any one of claims 1 to 6 wherein the polymeric binder at least partially coats the substrate core, and the plant hormone at least partially coats the binder-coated substrate core.

8. A granule of any one of claims 1 to 6 wherein the polymeric binder and plant hormone form a homogenous coating to at least partially coat the substrate core.

9. A granule of any one of claims 1 to 8 wherein the polymeric binder is selected from the group comprising a polyhydroxyl compound, a polymer or copolymer of a C_1–C_6 alkyl substituted with one or more groups selected from the group comprising lactams, preferably γ-lactam, or 2-pyrollidone, a latex, or a starch, and a combination thereof.

10. A granule of any one of claims 1 to 9 wherein the polymeric binder is a short chain polymer comprising about 7000 to about 10,000 units.

11. A granule of any one of claims 1 to 9 wherein the polymeric binder is a long chain polymer having about 80,000 to about 150,000 units.

12. A granule of any one of claims 1 to 11 wherein the plant hormone(s) is/are selected from the group consisting of one or more gibberellins, one or more auxins, one or more cytokinins, abscisic acid, ethylene, salicylic acid, one or more brassinosteroids, one or more jasmonates, one or more peptide hormones, one or more polyamines, nitric oxide, and one or more strigolactones.

13. A granule of any one of claims 1 to 12 comprising a surfactant.

14. A **method of producing a granule**, the method comprising
- providing a substrate core, a polymeric binder and a plant hormone,
- at least partially coating the substrate core with a coating that comprises the plant hormone,
- wherein the polymeric binder is
  - i) at least partially coated on the substrate core as a first coating (prior to the plant hormone-containing coating),
  - ii) mixed with the plant hormone, or
  - iii) both i) and ii) above.

15. A method of claim 14 wherein the granules are formed by by
- i) wet or dry mixing the substrate core, the one or more polymeric binders, and optionally the one or more additional agents and granulating the mixture, or
- ii) granulating the substrate core and at least partially coating the granule with the one or more polymeric binders, and optionally the one or more additional agents, and
- iii) at least partially coating the granule with the one or more plant hormones,

iv) any combination of (i) to (iii) above, and

recovering the granules.

16. A **method of applying a granule** of any one of claims 1 to 13 to a plant or a locus at which a plant is or is to be planted.

17. A method of claim 16 to improve plant health, production, or nutritional, environmental or economic value, or to improve the health-promoting or productive capacity or the nutritional, environmental or economic value of a locus where a plant is or is to be planted.

18. A method of claim 17 wherein the improvement is an improvement in yield.

19. A method of any one of claims 16 to 18 to increase pasture dry matter production by at least about 15% to about 50% and more preferably about 15% to about 20%.

20. A method of any one of claims 16 to 19 wherein the granules are applied before application of irrigation water or before a period of forecast rainfall.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ2016/050094

A. CLASSIFICATION OF SUBJECT MATTER

A01N 25/26 (2006.01) ***A01N 25/10 (2006.01)*** ***C05F 11/10 (2006.01)*** ***C05G 5/00 (2006.01)*** ***C05G 3/00 (2006.01)*** ***A01P 21/00 (2006.01)***

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, TXTE, CAPLUS, DWPI, INPADOC, AGRICOLA, GOOGLE, keywords: granul?, fertili?, ?polym?, core, coat?, bind?, ?lactam, ?pyrollidone, PVP, polyvinyl(w)alcohol, polyethylene(w)oxide, gum, starch, methacrylic, ?acrylate, kollicoat?, ?vinyl(w)acetate, latex, polyhydroxy?, ficoll?, PLANT 2W HORMONE?, PHYTOHORMONE?, PLANT W GROWTH W REGULAT+, GIBBERELLI+, ZEATIN, BRASSINOSTEROID, BRASSINOLIDE, ABSCISIC W ACID, ABSCISIN+, DORMIN, JASMONIC W ACID, JASMONAT+, +AUXIN+, INDOLE_"3"_ACETIC, IAA, INDOLE_"3"_BUTYRIC, INDOLEBUTYRIC W ACID, IBA, +NAPTHALENE_ACETIC, NAA, NAPHTHYLACETIC W ACID, SALICYLIC W ACID, KARRIKIN+, STRIGOLACTON+, ETHYLENE, POLYAMINE?, PEPTIDE W HORMONE?, A01N25/10/IC/CN, A01N25/26/IC/CN, A01N43/12/CN/LOW, (C05F11/10 L C05G3/0029) OR (C05G3/0029 L C05G3/0041), (C05F11/10 L C05G3/0029) OR (C05G3/0029 L C05G3/0041), (CAPLUS, DWPI, INPADOC Applicant/Inventor name search)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

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"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 August 2016	08 August 2016
Name and mailing address of the ISA/AU	**Authorised officer**
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au	Giuseppe Zagari AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262833130

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/NZ2016/050094**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO WO2014/080352 A1 (Balance Agri-Nutrients Limited) 30 May 2014 abstract; para 5, 6, 8-24, 29-31, 33-45, 117	1-20
X	Qiu, X, et al. "1-Naphthylacetic-acid-functionalized polyacrylate-coated urea with dual controlled-release properties" *Journal of Applied Polymer Science*. 2013, Vol. 129, No. 2, pages 559-567. Epub 3 November 2012 abstract, Figure 1; preparation at page 561, lhc	1-5, 8-20
X	WO 1999/007654 A1 (BEN GURION UNIVERSITY OF THE NEGEV RESEARCH AND DEVELOPMENT AUTHORITY) 18 February 1999 abstract; page 3, line 17 – page 4, line 8; Examples	1-20
X	WO 2004/000759 A1 (Kemira Growhow Oy) 31 December 2003 page 4, lines 15-29; page 6, lines 18, 20-25; page 7, lines 10-16; Claims 7, 13, 17; whole document	1-20
X	US 2004/0009878 A1 (Lynch et al.) 15 January 2004 abstract; para 9, 12, 14-18, 20-21, 24-26, 31, 33, 40-42, Examples D and G; claims 28-29	1-20
X	US 8497229 B2 (van Boxtel-Verhoeven et al.) 30 July 2013 abstract; column 1, lines 15-41 and column 5, lines 10-25; column 6, lines 40-49; column 7, lines 9-10, 20-21 and column 8, line 8 onwards; column 11, lines 18-30	1-20
X	US US2012/0015811 A1 (Dave et al.) 19 January 2012 abstract; para 5-7, 15-19, 53-54, 65	1-20
X	WO 2014/016751 A1 (RUDRARAM RESEARCH INSTITUTE OF AGRICULTURE & SCIENCES) 30 January 2014 abstract; page 1, line 10 – page 3, line 14; page 4, lines 22-25; page 11, lines 16-23; Examples page 11 onwards; Examples; claims	1-20
A	US 2015/0052960 A1 (KOCH AGRONOMIC SERVICES, LLC.) 26 January 2015 abstract; para 2-6, 17-24, 28-32, 38-41	6
A	WO 2015/001391 A1 (BASF (CHINA) COMPANY LIMITED) 08 January 2015 abstract; page 1, lines 8-10 and 37-38; whole document	6
P,X	WO 2015/075676 A1 (Balance Agri-Nutrients Limited) 28 May 2015 95, 101, 118; whole document	1-20

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/NZ2016/050094**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/NZ2016/050094**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		**Patent Family Member/s**	
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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

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This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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