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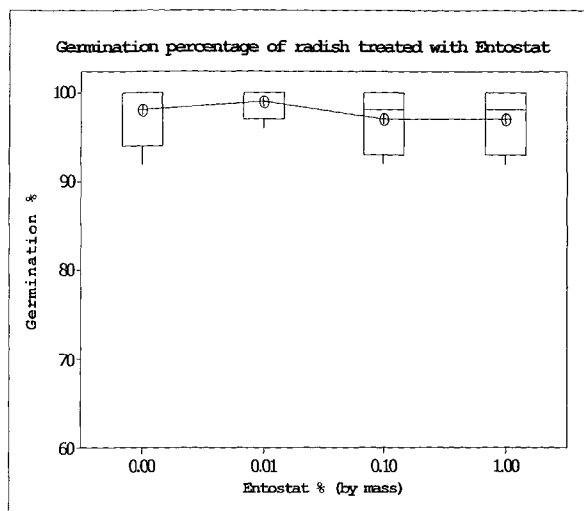
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(54) **Title:** COATING COMPOSITION FOR PLANT STRUCTURES

FIGURE 1



(57) **Abstract:** Coating composition for applying to plant structures, such as seeds, from which roots and shoots are capable of growing, wherein the said coating composition comprises one or more organic materials having a melting point of $\geq 50^{\circ}\text{C}$ Centigrade, methods of making such compositions and coated seeds.

COATING COMPOSITION FOR PLANT STRUCTURES

The present invention relates to coating compositions including an organic component for applying to plant structures of plants from which roots and shoots are capable of growing, uses of coating compositions on plant structures, methods of producing such coating compositions and plant structures coated with such coating compositions. In particular, the invention relates to coating compositions that comprise an organic material that is applied to plant structures, such as seeds, tubers, bulbs, and roots and plant structures coated with such coating compositions.

Plant structures, such as seeds, need to be placed in storage prior to sales and planting. Losses due to sub-optimal storage conditions are recorded annually and come about as a result of physiological dysfunction within the plant structures and this may be due to variations in the micro-environment surrounding the plant structure. This may be caused by abiotic stresses, and/or the presence of pathogens such as bacteria and fungi that can infest plant structures such as seeds at various stages of their development. Agronomic losses due to physiological dysfunction of plant structures remain high despite the employment of conventional plant structure coatings, such as seed coatings that typically include inorganic components such as mineral earth components e.g. diatomaceous earth and/or kaolin. Such conventional coatings are typically applied in the form of wet slurries to plant structures, such as seeds. Once applied, the coatings are typically dried on the plant structure and this may in turn give rise to abiotic stresses, and may result in deleterious consequences to the viability of the plant structure. Additionally, such coating techniques may not be applied evenly, and as a consequence, such coatings tend to be susceptible to chipping and/or flaking. Furthermore, the degree of coating uniformity over plant structures such as seeds of such conventionally applied coatings is not optimal, with a percentage of e.g. seeds of any one batch receiving little or no coating (up to 20% of the seeds, depending on the method being deployed, and the seed type undergoing a coating treatment).

Certain plant structure treatments, such as seed treatments are aimed at increasing shelf life of the plant structure when stored over time, for example, in a barn in sacks or on shelving in sheds, or in transport facilities such as trucks, plane, ships, and in warehouse storage areas and the like. Such treatments are typically aimed at providing direct protection against microbial infestation such as by fungi and bacteria. By protecting plant structures from such hazards, the durability of plant structures, such as seeds may be bettered.

It has now been found that by using certain organic component materials as coatings on seeds, the viability of plant structures such as seeds in storage is maintained at least to the level of

conventionally treated plant structures. Furthermore, it has been found that by using organic materials of use in the invention, coatings that are simpler to produce and more cost-effective to apply to plant structures than conventional plant structure coatings are now possible.

It is an object of the present invention to supply improved coatings for plant structures, such as seed coatings comprising organic components. This and other objects of the invention will become apparent from the following description and examples.

According to the present invention there is provided a plant structure coating composition, wherein the said coating composition comprises one or more organic materials selected from wax materials having a melting point of $\geq 50^{\circ}\text{C}$ Centigrade wherein the wax material is in the form of particles having a volume mean diameter of $\geq 10\mu\text{m}$.

For the purposes of the present invention a "plant structure" is one from which roots and shoots are able to grow. Such structures are typically bulbs, roots, rhizomes, seeds and "seed tubers". Reference to "seed" and "seeds" is used interchangeably herein and means seeds, typically viable seeds, to which compositions of the invention may be applied. Thus, a plant structure relates to seeds or other plant structures, such as "seed tubers", bulbs, rhizomes, roots and seeds for the provision of new plants for building up seed and plant propagation stocks for sale to farmers, growers and the like. Coated plant structures of the invention as provided herein means plant structures as defined hereinabove such as seeds that are capable of germinating to at least conventional levels of germination typical of the relevant plant species under consideration. "Plant structures" for the purposes of the present invention include oilseed plant seeds suitable for coating with compositions of the invention and include those selected from members of the Crucifer family (Canola (*B. campestris*) and oilseed rape (*B. napus*), sunflower, peanut, safflower, sesame, nut oils, carob, coriander, mustard, grape, flax, linseed, dika, hemp, okra, pine, poppy, castor, jojoba and the like; vegetable plant structures such as vegetable seeds or other structures, such as "seed tubers", for the provision of new plants for building up seed stocks for sale to farmers. Vegetable seeds and vegetable plant structures as provided herein means seeds and plant structures that are capable of germinating to at least conventional levels of germination typical of the relevant vegetable species under consideration. Thus a vegetable plant structure is one that may be grown for human or domesticated animal consumption. "Vegetable plant structures" includes those structures such as seeds, bulbs, roots and tubers, found in domestic vegetables. "Domestic vegetables" and "vegetable plants" for the purposes of the present invention are ones which are recognised as such by the skilled addressee. Vegetable plant structures suitable for coating with compositions of the invention include those selected from vegetable plant seeds from members of the Crucifer family

(cabbages, broccolis, cauliflowers, kales, Brussels sprouts, kohlrabis), onions, capsicums, tomatoes, cucurbits such as cucumbers, cantaloupes, summer squashes, pumpkins, butternut squashes, tropical pumpkins, calabazas, winter squashes, watermelons, lettuces, zucchinis (courgettes), aubergines, carrots, parsnips, potatoes such as white potato, swedes, turnips, sugar beet, celeriacs, Jerusalem artichokes, artichokes, bok choy, celery, Chinese cabbage, beans such as lima beans, green beans such as runner beans, haricot beans, French beans, broad beans, horse radish, leeks, musk melons, parsley, radish, spinach, sweet corn, beetroot for table consumption, peas and the like; "monocot plant structures" and "monocot seed" from which roots and shoots are able to grow include structures such as bulbs of monocot plants e.g. allium species and seeds of monocot plants. Reference to "monocot seed" and "monocot seeds" is used interchangeably herein and means seeds, typically viable seeds of monocotyledonous plants, to which compositions of the invention may be applied. "monocot seed" and "monocot seeds" as provided herein means seeds that are capable of germinating to at least conventional levels of germination typical of the relevant monocot plant species under consideration. "Monocot plants" for the purposes of the present invention are ones which are recognised as such by the skilled addressee. Monocot plant seeds suitable for coating with compositions of the invention includes those that may be used for the planting of monocotyledonous plants such as varieties of *Oryza* spp. such as *Oryza sativa* (rice), *Triticum* spp. such as *T. aestivum* (wheat: Spring and Winter varieties), *Secale* spp. such as *Secale cereale* (rye), *Avena* spp. such as *Avena sativa* (oats), *Zea* spp. such as *Zea mays* [corn (maize)], *Sorghum* spp. such as *Sorghum bicolor* (sorghum), *Hordeum* spp. such as *Hordeum vulgare* (two and five rowed barley) and hybrid crosses of monocotyledonous plants such as *x Triticosecale* (triticale: cross between wheat and rye) and the like; ornamental plant structures to which compositions of the invention may be applied include seeds, seed tubers, tuberous roots (sometimes referred to as 'tubers', e.g. dahlia 'tubers'), bulbs, corms and rhizomes. Viable ornamental plant structures such as seeds of ornamental plants as provided herein means that the seeds of ornamental plants are capable of germinating to conventional levels of germination typical of ornamental plant seeds or in the case of ornamental seed tubers, tuberous roots, bulbs, corms and rhizomes of growing roots and shoots. Thus, viable ornamental plant structures as herein defined may be used for the planting of ornamental plants such as varieties of tulip, amaryllis, hyacinth, daffodil, narcissus, cyclamen, lily, lily of the valley, iris, gladiolus, crocus, crocosmia, dahlia, snowdrop, bluebell, dahlia, freesia, gloxinia, anemone, fritillaria, alstromeria ligu and hybrids thereof, camassia esculenta, arum italicum, muscari, agapanthus, begonia, acidanthera, ranunculus, ornamental allium and the like. Examples of ornamentals seeds that may be coated with compositions of the invention include seeds of viola (pansy), primula, petunia, polyanthus, tagetes, pelargoniums including *P. peltatum*, begonia, cyclamen, achillea, ageratum, agrostemma, alyssum, amaranthus, antirrhinum, aquilegia, aster, calendula, campanula,

carnation, chrysanthemum, helleborus, cineraria, clematis, convolvulus, Centaurea cyanus, cosmea, dahlia, delphinium, dianthus, digitalis, myosotis, freesia, geranium, godetia, impatiens, cheiranthus cheiri, dianthus barbatus, lathyrus odoratus, salvia, salpiglossis, verbenas, zinnia and the like. The online Sutton Seeds catalogue 2010 herein incorporated by reference provides examples of many varieties of ornamental plant which may be treated with the coating compositions of the present invention. Woody ornamental plant structures may also be treated with compositions of the invention. Woody ornamental plant structures include seeds of ornamental plants such as members of the arborvitae, acer, azalea, Chamaecyparis, dogwood, euonymus, rose, forsythia, Fraser fir, hemlock, Japanese holly, juniper, Pieris, rhododendron, Taxus, white pine, maple, elm, aspen, ash, beech, oak and the like; cotton seed from which roots and shoots are able to grow. Cotton seed as provided herein means seeds that are capable of germinating to at least conventional levels of germination typical of cotton seed; and seeds of the Fabaceae, such as soya bean seed from which roots and shoots are able to grow. Seeds of the Fabaceae as provided herein, means seeds that are capable of germinating to at least conventional levels of germination typical of the Fabaceae under field planting conditions. Typical seeds of the Fabaceae include soya bean seeds.

The organic material of the invention is selected from organic materials that can be applied to plant structures such as seeds either as a powder wherein the powder particles are of a pre-determined volume mean diameter, or the powder particles are applied in liquid form, such as in an oleaginous formulation or as an aqueous formulation.

Generally, the organic materials employed in the invention comprise particles, such as composite particles of use in a dry powder composition of the invention and possess a volume mean diameter of a certain size as defined herein. To obtain particles of organic materials of a volume mean diameter applicable for use in the invention, organic materials in the form of, for example, 1 to 5 kilogram blocks or tablets may be broken up or kibbled into small millimetre-sized pieces (such as from 2mm – 8mm approximate diameter in size, for example from 4mm to 6mm) in a kibbling machine. The millimetre-sized pieces can then be passed through a comminuting means such as a standard mill, e.g. an Apex Comminuting mill, and milled or comminuted into particles having an approximate diameter in the range from 100µm - 500µm, for example from 250µm - 300µm. The micron-sized comminuted particles can then be passed through a micronising apparatus, such as an AFG micronising air mill to obtain particles of a desired VMD range, such as from 15µm - 20µm, that is of use in the present invention. The skilled addressee will appreciate that such procedures for obtaining small particles are known in the art. Preferably, dry powder compositions of the invention comprise particles, such as composite particles having a volume mean diameter of $\geq 10\mu\text{m}$, for example of 10µm, 11µm,

12 μ m, 13 μ m, 14 μ m, 15 μ m up to 40 μ m or any value there in between. As stated herein, the volume mean diameter of the composite particles is typically $\geq 10\mu$ m or $\geq 12\mu$ m and may lie in the range from 10 μ m to 200 μ m and may have a value that lies anywhere therein between, for example from $\geq 10\mu$ m to 100 μ m; or from $\geq 10\mu$ m to 40 μ m; or from $\geq 10\mu$ m to 30 μ m or any desired volume mean diameter value in between. Preferably, dry powder compositions of the invention comprise particles having a volume mean diameter of $\geq 10\mu$ m, for example of 10 μ m, 11 μ m, 12 μ m, 13 μ m, 14 μ m, 15 μ m and the like up to any volume mean diameter of choice, such as up to 200 μ m or any volume mean diameter in between for example 40 μ m or 30 μ m. Such compositions are considered to be less of a thoracic hazard to humans and are not thought to be allergenic.

In liquid formulations, particles of a pre-determined volume mean diameter (VMD) are suspended therein in a suspension formulation and applied to the plant structures such as seeds which are then dried using conventional drying procedures. Preferably, the organic material is applied to plant structures in a dry powder form; the particles of the organic material may have a volume mean diameter of any conventional size as hereinbefore described. Preferably still, such organic materials do not include added further components such as added UV blockers or added antioxidants or the like. Dry powders of the present invention may be made up of one or more organic materials that have a melting point at or above 50° Centigrade and which are of use in the present invention. Suitable organic materials of use in the invention include waxes having a melting point of $\geq 50^{\circ}\text{C}$, more preferably of $\geq 60^{\circ}\text{C}$, and most preferably are made up of hard waxes having a melting point of $\geq 70^{\circ}\text{C}$. Examples of natural waxes of use in the present invention include carnauba wax, beeswax, Chinese wax, shellac wax, spermaceti wax, myricyl palmitate, cetyl palmitate, candelilla wax, castor wax, ouricury wax, wool wax, sugar cane wax, retamo wax, rice bran wax and the like.

Synthetic waxes of use in the present invention include suitable waxes selected from paraffin wax, microcrystalline wax, Polyethylene waxes, Fischer-Tropsch waxes, substituted amide waxes, polymerized α -olefins and the like.

Mineral waxes of use in the invention include montan wax (e.g. Lumax® Bayer) ceresin wax, ozocerite, peat wax and the like.

Suitable organic materials are made up of particles of a size range as herein defined and may be selected from waxes such as carnauba wax, beeswax, montan wax, Chinese wax, shellac wax, spermaceti wax, candelilla wax, castor wax, ouricury wax, and rice bran wax or mixtures of two or more thereof. Such waxes typically display a high enthalpy of lattice energy during melt.

The organic material is in the form of wax particles as herein described and may be selected from waxes as also herein described, such as a plant wax, for example, carnauba wax that may be applied in liquid form, that is to say, in the form of a suspension of particles. Preferably, wax particles of use in the invention are applied to plant structures in dry powder form as discrete particles. Generally, the particles of use in the invention possess a volume mean diameter as hereinbefore described.

Additionally, the organic particles of use in compositions of the invention may contain other components such as additives selected from UV blockers such as beta-carotene or p-amino benzoic acid, colouring agents such as optical brighteners and commercially available colouring agents such as food colouring agents, plasticisers such as glycerine or soy oil, antimicrobials such as potassium sorbate, nitrates, nitrites, propylene oxide and the like, antioxidants such as vitamin E, butylated hydroxyl anisole (BHA), butylated hydroxytoluene (BHT), and other antioxidants that may be present, or mixtures thereof. The skilled addressee will appreciate that the selection of such commonly included additives will be made depending on end purpose, and perceived need. However, it is preferred if such components are not added to organic materials of use in the present invention.

Liquid formulations of the invention may be formulated as an aqueous formulation or as an oleaginous formulation, depending on design. Aqueous formulations may include surfactants selected from commercially available surfactants such as Tween 20, Silwet L77, Tween 80, Torpedo II, Newmans T80, Fortune, Guard, Rhino, Biopower, and the like.

Oleaginous formulations, that is to say oil-based formulations, may contain any oil suitable for use in the present invention which may be selected from petroleum oils, such as paraffin oil, and vegetable oils such as rapeseed oil, soybean oil, sunflower oil, palm oil and the like. Oil formulations of use in the invention contain organic particles of the invention as described herein and these in turn may be admixed with flow agents such as hydrophilic precipitated silicas, for example Sipernat 383 DS, Sipernat 320, EXP 4350, and Sipernat D-17 and the like. Such free-flowing agents may be dispersed in oils, for example, for anti-foaming purposes.

The skilled addressee will appreciate that where an aqueous or an oil formulation may be used, the liquid element should be removed from the coated plant structure after coating is achieved leaving the plant structure coated with particles, for example by drying off using conventional drying processes.

Coatings of organic materials of use in the present invention also serve to protect immediately

planted plant structures of the invention from soil borne pathogens, that is to say, ones that are able to colonise plant structures such as seeds, and/or pathogens that populate the soil and which are capable of acting on the planted plant structures.

Examples of soil borne bacterial and fungal pathogens that attack cotton plants include *Agrobacterium tumefaciens*, *Xanthomonas campestris* pv *malvacearum*, *Erwinia herbicola*, *Rhizoctonia* spp. e.g. *R. solani*, *Pythium* spp, *Sclerotium* spp. such as *S. rolfsii*, *Fusarium* spp. such as *F. oxysporum* f. sp. *vasinfectum*, *Phytophthora* spp., *Verticillium* spp. such as *V. dahliae*, *Phoma* spp. such *P. exigua*, *Alternaria* spp. such as *A. macrospora*, *A. alternata*, and the like.

Examples of soil borne bacterial and fungal pathogens that attack monocotyledonous plants include *Rhizoctonia* spp. (e.g. *R. microsclerotia* active against maize; and rice; sorghum; wheat; barley; oats; and rye;), *Aspergillus* spp. such as *A. flavus* and *A. niger* (e.g. active against maize), *Tilletia* spp. such as *T. tritici*, and *T. laevis* (e.g. active against wheat) *Sclerophthora* spp. such as *S. rayssiae*, and *S. graminicola* (e.g. active against maize), *Peronosclerospora* spp. such as *P. sorghi* and *P. spontanea* (e.g. active against maize). *Pythium* spp. (e.g. active against maize; rice; sorghum; wheat; barley; oats; rye), *Fusarium* spp. (e.g. active against maize; rice; sorghum; wheat; barley; oats; rye), *Claviceps* spp. such as *C. purpurea* (e.g. active against rye; triticale; wheat; and barley), *C. africana* (e.g. active against sorghum), *C. gigantea* (e.g. active against maize), *Gibberella* spp. such as *G. Avenacea* (e.g. active against maize), *Burkholderia glumae* (e.g. active against rice) *Pseudomonas fuscovaginae* (e.g. active against rice), *Sclerophthora* spp. such as *S. macrospora* (e.g. active against rice), *Cochliobolus* spp. such as *C. miyabeanus* (e.g. active against rice), *Fusarium* spp. (active against rice, oats, wheat; maize), and the like.

Examples of soil borne bacterial and fungal pathogens that attack ornamental plants include species of *Rhizoctonia solani* (e.g. active against verbena; anemone; dahlia; impatiens; primula; poinsettia), *Chalara elegans* (e.g. active against verbena; cyclamen), *Cylindrocarpon destructans* (e.g. active against cyclamen), *Cylindrocladiella peruvania* (e.g. active against cyclamen), *Erwinia chrysanthemi* (e.g. active against *Euphorbia pulcherrima* (poinsettia)), *Pythium* spp (e.g. active against impatiens; primula), *Agrobacterium tumefaciens* (e.g active against anemone; carnation; dahlia; geraniums (pelargonium); primula; poinsettia), *Phytophthora* spp. (e.g. active against impatiens; geraniums (pelargonium)); species such as *phytophthora tentaculata* (e.g. active against Chrysanthemum, Verbena, and Delphinium species, *Sclerotinia sclerotiorum*, *Fusarium* spp., and *Verticillium* spp., such as *Verticillium albo-atrum* (e.g. active against woody ornamentals such as maple, elm, aspen, ash, beech, and oak;

chrysanthemum) and the like.

Examples of fungal pathogens that attack soya bean plants include *Rhizoctonia* spp. such as *R. solani*, *Aspergillus* spp., *Pythium* spp, *Sclerotium* spp. such as *S. rolfsii*, *Fusarium* spp., *Phytophthora* spp., *Alternaria* spp., and the like.

Examples of soil borne bacterial and fungal pathogens that attack vegetable plants include *Rhizoctonia* spp. (active against e.g. beans, cucurbits; *R. solani* active against *Brassica* spp. peas; lettuces, spinach, potato), *Pythium* spp, (active against e.g. beans, carrot, celery, *Brassica* spp., cucurbits, eggplant, lentils, peas, peppers, spinach, lettuce, potato and tomato), *Fusarium* spp. (active against e.g. beans, cucurbits, tomato, peas, potato), *Phytophthora* spp. (active against e.g. beans and lentils, cucurbits, tomato, spinach, potato; *P. megasperma* active against *Brassica* spp.), *Verticillium* spp. such as *V. albo-atrum* and *V. dahliae* (active against *Brassica* spp., tomato, potato), *Sclerotium* spp. (active against e.g. beans), *Agrobacterium tumefaciens* (active against *Brassica* and *Raphanus* spp.), *Phoma* spp.(active against peas) such as *Phoma lingam* (active against *Brassica* spp.), *Erwinia* spp. (active against cucurbits, tomato, lettuces, potato), *Pseudomonas* spp. (active against cucurbits, tomato, spinach, potato), *Alternaria* spp. (active against cucurbits, lettuces, peas, tomato, potato), *Penicillium* spp. (active against cucurbits), *Streptomyces* spp. (active against potato), and the like.

Examples of soil borne bacterial and fungal pathogens that attack oilseed plants include *Rhizoctonia* spp. (active against e.g. rapeseed, canola, cotton; *R. solani* active against *B. napus* and *B. campestris*), *Peronospora* spp. such as *P. parasitica* (active against *B. napus* and *B. campestris*) *Pythium* spp, (active against e.g. canola and oilseed rape, sunflower; cotton), *Fusarium* spp. (active against sunflower; cotton) such as *F. oxysporum* (active against e.g. canola and oilseed rape), *Phytophthora* spp. (active against e.g. canola and oilseed rape e.g. *P. megasperma*), *Verticillium* spp. (active against sunflower) such as *V. longisporum* (active against *Brassica* spp. such as *B. napus* and *B. campestris*), *Sclerotium* spp. (active against e.g. canola), *Agrobacterium tumefaciens* (active against sunflower and *Brassica* spp. e.g. canola), *Phoma* spp.(active against sunflower) such as *Phoma lingam* (active against *Brassica* spp.), *Pseudomonas* spp. (active against sunflower; and canola e.g. *P. syringae* pv *maculicola*), *Alternaria* spp. (active against canola, sunflower, cotton), and the like.

According to a further aspect of the invention there is provided use of organic material in the form of particles in the manufacture of a plant structure coating composition as defined herein. The organic materials are selected from one or more organic materials having a melting point of $\geq 50^{\circ}\text{C}$ Centigrade, more preferably of $\geq 60^{\circ}\text{C}$ and most preferably are made up of hard waxes

having a melting point of $\geq 70^{\circ}\text{C}$. Examples of natural waxes of use in the present invention include carnauba wax, beeswax, Chinese wax, shellac wax, spermaceti wax, myricyl palmitate, cetyl palmitate, candelilla wax, castor wax, ouricury wax, wool wax, sugar cane wax, retamo wax, rice bran wax and the like.

Synthetic waxes of use in the present invention include suitable waxes selected from paraffin wax, microcrystalline wax, Polyethylene waxes, Fischer-Tropsch waxes, substituted amide waxes, polymerized α -olefins and the like.

Mineral waxes of use in the invention include montan wax (e.g. Lumax® Bayer) ceresin wax, ozocerite, peat wax and the like.

Suitable organic materials include carnauba wax, beeswax, montan wax, Chinese wax, shellac wax, spermaceti wax, candelilla wax, castor wax, ouricury wax, and rice bran wax or a mixture of one or more thereof, and preferably, the plant structure coating that is used includes carnauba wax. More preferably, the plant structure coating consists essentially of a single wax, such as carnauba wax as a primary component and does not include a second wax. Preferably, in this aspect of the invention, the organic particles have a mean volume diameter $\geq 10\mu\text{m}$, such as from $\geq 10\mu\text{m}$ to $200\mu\text{m}$, as herein described and as appropriate for the plant structures to which the particles are to be applied. Naturally, the skilled addressee will appreciate that the size of the organic particles to be applied to plant structures will depend on the size of the plant structure, and the type or form of the plant structure that is contemplated for coating.

In a third aspect of the invention there is provided a method of manufacturing a plant structure coating composition as herein described that comprises

- i) selecting at least one solid wax having a melting point of $\geq 50^{\circ}\text{C}$; and
- ii) machining said wax into particles of a mean volume diameter of $\geq 10\mu\text{m}$, such as in the range from $\geq 10\mu\text{m}$ to $200\mu\text{m}$.

The organic material in this aspect of the invention may be selected from organic materials such as from organic waxes having a melting point of $\geq 50^{\circ}\text{C}$, more preferably of $\geq 60^{\circ}\text{C}$, and most preferably the organic material is made up of at least one hard wax having a melting point of $\geq 70^{\circ}\text{C}$. Examples of natural waxes of use in the present invention include carnauba wax, beeswax, Chinese wax, shellac wax, spermaceti wax, myricyl palmitate, cetyl palmitate, candelilla wax, castor wax, ouricury wax, wool wax, sugar cane wax, retamo wax, rice bran wax and the like.

Synthetic waxes of use in the present invention include suitable waxes selected from paraffin wax, microcrystalline wax, Polyethylene waxes, Fischer-Tropsch waxes, substituted amide waxes, polymerized α -olefins and the like.

Mineral waxes of use in the invention include montan wax (e.g. Lumax® Bayer) ceresin wax, ozocerite, peat wax and the like.

Suitable waxes for use in the invention include carnauba wax, beeswax, montan wax, Chinese wax, shellac wax, spermaceti wax, candelilla wax, castor wax, ouricury wax, and rice bran wax or a mixture of one or more thereof. Preferably, the selected organic material includes a substantial proportion of carnauba wax up to 100%, for example 1%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% or more or any proportion therein between, the rest being made up of at least one other organic material compatible for purpose and as herein defined. Preferably, the selected organic material is solely carnauba wax which may contain further added components as herein defined, such as UV blockers, antioxidants such as vitamin E and the like.

In a further aspect of the invention, there is provided a plant structure coating composition, such as a seed coating composition produced by the method as described herein.

In a further aspect of the invention there is provided a coating composition as described herein for use on plant structures, such as seeds. The plant structure may be selected from oilseeds, vegetable seeds, cotton seeds, monocotyledon seeds, ornamental plant seeds or seeds of the Fabaceae, such as soya bean seeds.

In a further aspect of the invention there is provided a method of coating plant structures such as plant seed with a coating composition that comprises one or more organic materials as herein defined the method comprising

- i) obtaining organic material as a population of separate particles of a pre-determined VMD, such as $\geq 10\mu\text{m}$, for example within the range $\geq 10\mu\text{m} - 200\mu\text{m}$; and
- ii) applying the said population of particles of i) to plant structures.

In this method of the invention, the coating composition preferably comprises a particulate composition that is applied to plant structures in dry particulate form. Furthermore, the coating composition comprises an organic material selected from waxes having a melting temperature of $\geq 50^\circ\text{Centigrade}$. The wax may be selected from carnauba wax, beeswax, montan wax, Chinese wax, shellac wax, spermaceti wax, candelilla wax, castor wax, ouricury wax, and rice

bran wax or mixtures of two or more thereof.

The skilled addressee will appreciate that environmental factors that may affect plant structure viability includes such factors as extremes of heat, loss of moisture and the presence of pathogens such as bacteria and/or fungi. The skilled addressee will also appreciate that the pre-determined VMD will be appropriate to the seed size of the plant structures to which the coating is to be applied.

In a variant of this aspect of the invention there is provided a method of coating plant structures with a coating composition that comprises an organic material, the method comprising

- i) obtaining organic material selected from waxes suitable for coating plant structures;
- ii) heating the organic material so as to form a liquid phase or a gaseous phase;
- iii) cooling the liquid phase or gaseous phase of ii) to below the melting point of the organic material, forming a solid;
- iv) machining the solid organic material of step iii) into particles of a pre-determined VMD as herein defined; and
- v) applying the particles of iv) to plant structures.

The organic material of use in the invention may comprise one or more organic materials selected from organic materials as herein defined. Preferably, the organic material is carnauba wax. Where two or more organic materials of use in the invention are employed as the organic material in a plant structure coating composition of the invention they may be heated together so as to form a liquid phase or a gaseous phase during which phases the organic material may be mixed, if required. Once the organic materials are mixed they may be cooled to below the melting point of the organic material possessing the lowest melting point in the liquid phase (where a gas phase is employed, this will be cooled to a liquid phase), forming a solid which may then be machined, such as by comminution, into particles of a pre-determined VMD as herein defined using conventional procedures. Once the organic material is in the form of particles of a known VMD, such as dry particles, it may be applied to plant structures, such as seeds, using conventional means, e.g. by tumbling in a drum mixer.

The treatment composition is applied to the plant structures in dry particulate form or in liquid form as hereinbefore described, and preferably in dry particulate form. The organic carrier material in the above aspect and variant aspect of the invention may be selected from organic materials selected from organic waxes having a melting point of $\geq 50^{\circ}\text{C}$, more preferably of $\geq 60^{\circ}\text{C}$, and most preferably are made up of hard waxes having a melting point of $\geq 70^{\circ}\text{C}$. Suitable waxes for use in the invention include carnauba wax, beeswax, montan wax, Chinese

wax, shellac wax, spermaceti wax, candelilla wax, castor wax, ouricury wax, and rice bran wax or a mixture of one or more thereof. Preferably, the selected organic material includes a substantial proportion of carnauba wax up to 100%, for example 1%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% or more or any proportion therein between, the rest being made up of at least one other organic material as herein defined. Preferably, the selected organic material is solely carnauba wax which may contain further added components as herein defined, such as UV blockers, antioxidants such as vitamin E and the like.

Generally, the particles of use in the above aspect of the invention and the variant aspect of the invention possess a volume mean diameter of $\geq 10\mu\text{m}$, such as $\geq 12\mu\text{m}$ such as in the range of from $\geq 10\mu\text{m}$ to $200\mu\text{m}$, for example from $\geq 10\mu\text{m}$ to $100\mu\text{m}$; or from $\geq 10\mu\text{m}$ to $40\mu\text{m}$; or from $\geq 10\mu\text{m}$ to $30\mu\text{m}$ or any desired volume mean diameter value in between. Preferably, dry powder compositions of the invention comprise particles having a volume mean diameter as hereindescribed.

In a further aspect of the invention there is provided use of a plant structure composition as described herein in controlling soil born pathogen contact with plant structures selected from seeds, bulbs, roots, tubers including seed tubers, rhizomes, and corms. In a preferment of this aspect of the invention the plant structure composition is a seed coating composition. Thus there is provided use of a seed coating composition of the invention in controlling soil born pathogen contact with seeds.

In a further aspect of the invention there is provided use of a plant structure composition as herein described in controlling germination delay in plant structures selected from seeds, bulbs, roots, tubers including seed tubers, rhizomes, and corms. In a preferment of this aspect of the invention the plant structure composition is a seed coating composition. Thus there is provided use of a seed coating composition of the invention in controlling germination delay in seeds.

In a preferment of the above two aspects of the invention, the seeds are selected from seeds of oil seed bearing plants, seeds of vegetable plants, cotton seeds, seeds of monocotyledonous plants, seeds of ornamental plants or seeds of plants of the Fabaceae, such as soya bean seeds. Examples of the kind of plant species that the above two use aspects of the invention may be applied include those as hereinbefore defined.

There now follow examples and figures that illustrate the invention. It is to be understood that the examples are not to be construed as limiting the invention in any way.

Figure 1: Germination percentage of radish treated with Entostat.

Figure 2: Percentage germination over time (radish)

Examples Section

Seed Germination and Storage Examples

Canola

1. Moisture Testing

Canola seeds are supplied in sealed bags at low humidity. Once opened seeds are likely to gain or lose moisture in exchange with the ambient air. As moisture content is a key component in both germination and storage (Welty Phytopathology, 1987 and Ellis, Annals of Botany 1990) *initial determination of moisture content is essential to identify potential variability.*

A sample of seed is checked for purity and any broken seed and contaminants (e.g. weed seeds) removed. Two 5g subsamples of whole seed are placed in oven proof containers with lids and weighed to determine the wet weight. The containers are then placed in a forced air circulation oven for 16 hours at $105^{\circ}\text{C} \pm 2^{\circ}\text{C}$. Lids are removed during drying but are also placed in the oven. The samples are then placed in a desiccator to cool for 20 minutes before being weighed a second time to determine their dry weight. The lids are placed on the containers while cooling and weighing. The loss of weight represents the weight of water in the undried sample. This weight is divided by the wet weight to obtain the percentage moisture content.

2. Seed Weight

Used as a measure of the homogeneity of the seed batch. Eight replicates of 25 seeds are weighed and the coefficient of variation recorded. This coefficient should not exceed a value of 5. If it does then the procedure is repeated and the mean of all 16 samples used to calculate the number of seeds per gram.

3. Germination

The optimum conditions for germination, including: temperature, humidity and light regime are supplied by the seed merchant are adhered to.

Seeds are sterilised using a 4% sodium hypochlorite solution and then well rinsed with sterile water to destroy any fungal or bacterial spores present on the testa, some of which may be pathogenic and therefore effect germination and/or growth.

Treatments

- a. T_0 – untreated seed (control)
- b. T_1 – tumbled seed (application method control)
- c. T_2 – seed + carnauba wax particles (15 μ m VMD) at 3:1 ration (by mass)
- d. T_3 – seed + carnauba wax particles (15 μ m VMD) at 9:1 ration (by mass)
- e. T_4 – seed + carnauba wax particles (70 μ m VMD) at 3:1 ration (by mass)
- f. T_5 – seed + carnauba wax particles (70 μ m VMD) at 9:1 ration (by mass)

A homogeneous mix is attained through tumbling seed and carnauba wax formulation in a cylinder, adapted to produce lateral mixing/tumbling through the inclusion of angled interior vanes, placed on a Wheaton roller (Wheaton Industries Inc., NJ, USA) for 30 minutes.

6 replicates of 25 seeds per treatment are placed on Whatman Type 181 Seed test Papers in 9cm petri dishes. 4ml of sterile water is added to each dish.

$$((6 \times 25) \times 6) = (150 \times 6) = 900 \text{ seeds}$$

The samples are then placed in incubators set at the optimal conditions for germinations based on information from the seed supplier (Herbiseed, Twyford, UK).

Germination is the number of normal seedlings produced from the 25 seeds expressed as a percentage. A normal seedling has all the essential plant structures necessary for the plant to continue to grow normally under favourable conditions. Germination testes are performed in cooled incubators (Thermocabinet, Tintometer, UK) with temperature $\pm 1^\circ\text{C}$. Samples are randomised with the incubator based on a block design.

Samples are observed for 21 days at 3 day intervals. In addition to the final germination percentage, germination energy is recorded. This is defined as the germination percentage when the mean daily germination (cumulative germination percentage/time elapsed since sowing) reaches its peak. This is used as a measure of germination speed and potential seedling vigour.

Germination Value (GV) is a composite value combining germination speed and total germination.

$$GV = (DGs/N) \times (GP/10)$$

GV = germination value

GP = germination % at the end of the trial

DG = daily germination speed obtained by dividing the cumulative germination percentage by the no. of days since sowing

DGs = the total germination obtained by adding every DG value obtained from the daily counts.

Germination value will be used in the statistical analysis of the data with ANOVA.

4. Seedling Vigour and Growth

A uniform sample of 100 seeds (size and colour) is selected from the batch.

12 seeds for each treatment (total = 72) are sown in individual 7cm square plastic pots.

The pots are filled with a sieved, heat-sterilised potting mix (John Innes Seed Compost) nearly to the brim. They are then lightly tamped and watered using a fine rose. A single seed is then placed on the surface of the soil and covered with a thin layer of sieved compost or light sand to a depth of 2-3x the diameter of the seed, as per supplier recommendation.

Pots are then placed in a thermostatically controlled electric heated propagator (Vitopod, Garden Sensations, UK). The pots are divided into four blocks with 18 pots per block (3 replicates of each treatment). Pots are randomised within blocks to reduce the possibility of variation as a result of environmental conditions.

Light is provided using a twin bulb T5 lighting array suspended 150mm above the propagator (Lightwave T5, 48w, 3300 lumens). T5 tubes (6500 Kelvin) deliver the bright blue/white light required by the plant for growth without emitting much heat which may scorch tender seedlings.

Time until emergence (germination) is recorded at the point at which the cotyledons become visible. After 21 days the seedlings are removed from the pots and root weight (fresh) and shoot weight (fresh) are recorded in addition to total leaf number.

Statistical differences between treatments will be assessed using ANOVA.

5. Shelf Life/Storage

The treatment producing the best germination results is used to assess the effect of carnauba wax particles on the storage longevity of seeds.

Six samples of seed are taken and divided into two. The first set of samples is placed in sealed

bags and stored under optimal conditions (temperature and moisture content). The second set is stored in containers at room temperature.

One sample from each set is tested at 6, 12, and 18 months. The moisture content, germination and seedling vigour tests described above are repeated at each time point in order to assess the effect of storage over time.

The above procedures are applied on seeds of each of rapeseed, sunflower and linseed.

Cotton Seed

The procedures outlined in the oilseed section are applied to seeds of cotton.

Monocots

The above procedures are applied to seeds of each of wheat, rice, maize (corn), and sorghum.

Ornamentals

The above procedures are applied on seeds of each of viola, tagetes, cyclamen and impatiens.

Soya Bean

The above procedures are applied on seeds of soya bean.

Vegetables

The above procedures are applied on seeds of each of tomato, peppers, peas and summer squash.

6. Seed Germination and Storage

Germination– Radish, Cherry Belle (Herbiseeds, Twyford, UK)

The optimum conditions for germination, including: temperature, humidity and light regime are supplied by the seed merchant and were followed.

Seeds are sterilised using a 4% sodium hypochlorite solution and then well rinsed with sterile water to destroy any pathogenic fungal or bacterial spores present on the testa that may affect germination and/or growth.

Treatments

- a. T_0 – untreated seed (control)
- b. T_1 – tumbled seed (application method control)

- c. T_2 – seed + carnauba wax particles (15 μ m VMD) at 0.01% (by mass)
- d. T_3 – seed + carnauba wax particles (15 μ m VMD) at 0.1% (by mass)
- e. T_4 – seed + carnauba wax particles (15 μ m VMD) at 1% (by mass)

A homogeneous mix is attained through tumbling seed and carnauba wax formulation in a cylinder, adapted to produce lateral mixing/tumbling through the inclusion of angled interior vanes, placed on a Wheaton roller (Wheaton Industries Inc., NJ, USA) for 30 minutes.

4 replicates of 25 seeds per treatment are placed on Whatman Type 181 Seed test Papers (9cm diameter) in 9cm petri dishes. 5ml of sterile water is added to each dish.

$$((4 \times 25) \times 5) = (100 \times 5) = 500 \text{ seeds}$$

The samples are then placed in incubators set at 25°C.

Germination is the number of normal seedlings produced from the 25 seeds expressed as a percentage. A normal seedling has all the essential plant structures necessary for the plant to continue to grow normally under favourable conditions. Germination tests are performed in cooled incubators (Thermocabinet, Tintometer, UK) with temperature $\pm 1^\circ\text{C}$. Samples are randomised with the incubator based on a block design.

Samples are observed for 9 days at 1 day intervals and final germination percentage is recorded. Results are shown in Figure 1.

One-way ANOVA: Germination versus Entostat

Source	DF	SS	MS	F	P
Entostat	3	11.0	3.7	0.30	0.827
Error	12	148.0	12.3		
Total	15	159.0			

Grouping Information Using Tukey Method

Entostat	N	Mean	Grouping
0.01	4	99.000	A
0.00	4	98.000	A
1.00	4	97.000	A
0.10	4	97.000	A

Germination of radish seed was delayed through the addition of Entostat at 1% by mass, with no significant reduction in germination percentage. Results are shown in Figure 2.

Delayed germination may be useful if a stand is to be sown at different times and uniform emergence is required. Equally, this could be beneficial if the planting of the crop is to be staggered to facilitate harvesting.

Emergence Comparison to Commercially Treated seed (*Brassica napus* treated with Modesto, Bayer CropScience, Monheim, Germany)

A uniform sample of 400 seeds (size and colour) is selected from the batch ("Sesame", LS Plant Breeding) and half is treated with Entostat (0.1% by mass). The remaining half is used as the untreated control. In addition, a sample of commercially treated seed ("Sesame", LS Plant Breeding, treated with Modesto) was used as a third treatment. Each treatment is replicated three times.

20 seeds for each treatment (total = 40) are sown in 20 cell modular seed trays with an individual cellsize: Length 37mm x Width 37mm x Depth 65mm.

The pots are filled with a sieved, heat-sterilised seed mix (Levingtons F1 Seed and Modular Compost – Low Nutrient)) to level with the top of the cell. They are then lightly tamped and 30ml of deionised water added to each cell through a coarse filter. A single seed is then placed on the surface of the soil and covered with a thin layer of vermiculite to a depth of 2-3x the diameter of the seed, as per supplier recommendation. The trays are placed within plastic gravel trays (two per tray) which are lined with capillary matting to aid watering.

The gravel trays are then placed in a thermostatically controlled electric heated propagator (Vitopod, Garden Sensations, UK). Trays are randomised within blocks to reduce the possibility of variation as a result of environmental conditions.

Light is provided using a four bulb T5 lighting array suspended 150mm above the propagator (Lightwave T5, 4 x 48w, 16,600 lumens). T5 tubes (6500 Kelvin) deliver the bright blue/white light required by the plant for growth without emitting much heat which may scorch tender seedlings.

Time until emergence (germination) is recorded at the point at which the cotyledons become visible. After 15 days the total germination percentage is recorded.

Statistical differences between treatments are assessed using ANOVA.

Results:

OSR	Germination % after 15 days			Significance Relationship (Tukey)
Treated with:	1	2	3	
0.10%	100	95	100	a
Modesto	95	100	95	a
Untreated	95	95	100	a

One-way ANOVA: Germination% versus Treatment

Source	DF	SS	MS	F	P
Treatment	2	5.56	2.78	0.33	0.729
Error	6	50.00	8.33		
Total	8	55.56			

No significant differences were observed between treatments.

Germination after prolonged Storage

Test seed was obtained from Herbiseeds (Twyford, UK) and lower grade or older seed was deliberately selected in order to highlight any trends.

Seeds used:

Crop	Variety	Year	Condition (as described by Herbiseeds)
Oilseed Rape	Apex	2008	not stated
Soybean	Amsoy Non-GM	2010	60% germination
Wheat	Hereward	2010	Commercial Poor
Cotton	DP69	2008	not stated
Viola	sp.arvensis	2006	Low Commercial
Field Bean	n/a	2009	not stated

20g samples of seed were treated with 0.1% (by mass) Entostat and stored in unsealed bags at ambient temperature and humidity (not controlled) together with untreated samples. Germination percentage was determined for treated and untreated seed of all crop types using the method described above.

Results:

<i>Crop</i>	<i>Seeds Used</i>	<i>Replication</i>
OSR	25	4
Soybean	10	4
Cotton	10	4
Wheat	10	4
Viola	25	4
Field Bean	5	4

Grouping Information Using Tukey Method

<i>OSR</i>	<i>Months Storage</i>	<i>N</i>	<i>Mean % germination</i>	<i>Grouping</i>
Treated	0	4	88.000	A
Untreated	0	4	87.000	A

<i>Soybean</i>	<i>Months Storage</i>	<i>N</i>	<i>Mean % germination</i>	<i>Grouping</i>
Treated	0	4	67.500	A
Untreated	0	4	65.000	A

<i>Cotton</i>	<i>Months Storage</i>	<i>N</i>	<i>Mean % germination</i>	<i>Grouping</i>
Untreated	0	4	80.000	A
Treated	0	4	80.000	A

<i>Viola</i>	<i>Months Storage</i>	<i>N</i>	<i>Mean % germination</i>	<i>Grouping</i>
Untreated	0	4	98.000	A
Treated	0	4	96.000	A

<i>Wheat</i>	<i>Months Storage</i>	<i>N</i>	<i>Mean % germination</i>	<i>Grouping</i>
Treated	0	4	97.500	A
Untreated	0	4	95.000	A

<i>Field bean</i>	<i>Months Storage</i>	<i>N</i>	<i>Mean % germination</i>	<i>Grouping</i>
Untreated	0	4	95.0	A
Treated	0	4	95.0	A

Means that do not share a letter are significantly different

We conclude that the additional of Entostat at 0.1% by mass to the above seed types has no deleterious effect on the viability of seed on the evidence presented herein.

It is worth noting that several seeds exhibited fungal growth during germination testing and this seemed to be a characteristic prevalent in untreated seed.

CLAIMS

1. A plant structure coating composition, wherein the said coating composition comprises one or more organic materials selected from wax materials having a melting point of $\geq 50^{\circ}\text{C}$ wherein the wax material is in the form of particles having a volume mean diameter of $\geq 10\mu\text{m}$.
2. A coating composition according to claim 1 wherein the wax material is selected from waxes such as carnauba wax, beeswax, montan wax, Chinese wax, shellac wax, spermaceti wax, candelilla wax, castor wax, ouricury wax, and rice bran wax; or a mixture of two or more thereof.
3. A coating composition according to claim 1 or claim 2 wherein the organic material is in the form of particles having a volume mean diameter of within the range $10\mu\text{m}$ to $200\mu\text{m}$.
4. A coating composition according to any one of the preceding claims wherein the particles are carnauba wax particles.
5. A coating composition according to any one of the preceding claims wherein the particles of the coating composition are in a dry particulate form.
6. Use of organic material in the form of particles in the manufacture of a coating composition for plant structures according to any one of claims 1 to 5.
7. Use according to claim 6 wherein the particles are selected from carnauba wax, beeswax, montan wax, Chinese wax, shellac wax, spermaceti wax, candelilla wax, castor wax, ouricury wax, and rice bran wax; or a mixture of two or more thereof.
8. Use according to claim 6 or claim 7 wherein the plant structure coating composition comprises particles of carnauba wax.
9. Use according to any one of claims 6 to 8 wherein the organic particles have a volume mean diameter of $\geq 10\mu\text{m}$.
10. Use according to claim 9 wherein the particles have a volume mean diameter from $\geq 10\mu\text{m}$ to $200\mu\text{m}$.

11. A method of manufacturing a plant structure coating composition according to any one of claims 1 to 5 that comprises
 - i) selecting at least one solid wax having a melting point of $\geq 50^{\circ}\text{Centigrade}$; and
 - ii) machining said wax into particles of a desired volume mean diameter of $\geq 10\mu\text{m}$.
12. A method according to claim 11 wherein the particles of wax have a volume mean diameter value selected from the range $\geq 10\mu\text{m}$ to $200\mu\text{m}$.
13. A method according to claim 11 or claim 12 wherein the wax is selected from carnauba wax, beeswax, montan wax, Chinese wax, shellac wax, spermaceti wax, candelilla wax, castor wax, ouricury wax, and rice bran wax; or a mixture of two or more thereof.
14. A method according to any one of claims 11 to 13 wherein the wax material is carnauba wax.
15. A plant structure coating composition produced by the method of any one of claims 11 to 14.
16. A coating composition according to any one of claims 1 to 5 or claim 15 for use on plant structures.
17. A coating composition according to any one of claims 1 to 5, 15 or 16 wherein the plant structure is selected from oilseeds, vegetable seeds, cotton seeds, monocotyledon seeds, ornamental plant seeds or seeds of the Fabaceae, such as soya bean seeds.
18. A method of coating plant structures with a coating composition according to any one of claims 1 to 5, the method comprising
 - i) obtaining organic material as a population of separate particles of a pre-determined VMD; and
 - ii) applying the population of particles of i) to plant structures.
19. A method according to claim 18 wherein the coating composition comprises a particulate composition that is applied to plant structures in dry particulate form.
20. A method according to claim 18 or claim 19, wherein the coating composition comprises an organic material selected from waxes having a melting temperature of $\geq 50^{\circ}\text{Centigrade}$.

21. A method according to any of claims 18 to 20 wherein the coating composition comprises an organic material that is a wax in particulate form selected from carnauba wax, beeswax, montan wax, Chinese wax, shellac wax, spermaceti wax, candelilla wax, castor wax, ouricury wax, and rice bran wax or mixtures of two or more thereof.
22. A method of coating plant structures with a coating composition according to any one of claims 1 to 5, 15, 16, and 17, the method comprising
- i) obtaining organic material selected from waxes suitable for coating plant structures;
 - ii) heating the organic material so as to form a liquid phase or a gaseous phase;
 - iii) cooling the liquid phase or gaseous phase of ii) to below the melting point of the organic material, forming a solid;
 - iv) machining the solid organic material of step iii) into particles of a pre-determined VMD as herein defined; and
 - v) applying the particles of iv) to plant structures.
23. A method according to claim 22 wherein the particles of v) are applied to the plant structure in the form of dry particles.
24. A method according to claim 22 or claim 23 wherein the plant structure is a plant seed.
25. A method according to any one of claims 18 to 24 wherein the wax is carnauba wax.
26. Plant structures comprising a coating composition according to any one of claims 1 to 5 and claims 15 to 17.
27. Use of a plant structure composition according to any one of claims 1 to 5, 15, 16, and 17 in controlling soil borne pathogen contact with plant structures selected from seeds, bulbs, roots, tubers including seed tubers, rhizomes, and corms.
28. Use according to claim 27 wherein the plant structures are seeds.
29. Use of a plant structure composition according to any one of claims 1 to 5, 15, 16, and 17 in controlling germination delay in plant structures selected from seeds, bulbs, roots, tubers including seed tubers, rhizomes, and corms.
30. Use according to claim 29 wherein the plant structures are seeds.

31. Use according to any one of claims 27 to 30 wherein the plant structure is selected from seeds of oil seed bearing plants, seeds of vegetable plants, cotton seeds, seeds of monocotyledonous plants, seeds of ornamental plants or seeds of plants of the Fabaceae.

32. Use according to any one of claims 27 to 30 wherein the plant structures are selected from seeds of *Oryza spp.*, *Triticum spp.*, *Secale spp.*, *Avena spp.*, *Zea spp.*, *Sorghum spp.*, *Hordeum spp.*, and hybrid crosses of monocotyledonous plants; oilseeds of the Crucifer family; seeds of the Asteraceae family; seeds of the Linaceae family; seeds of the Malvaceae family; and seeds of the Fabaceae family.

33. Use according to any one of claims 27 to 32 wherein the plant structures are selected from seeds of *Oryza sativa*, *Triticum aestivum*, *Secale cereale*, *Avena sativa*, *Zea mays*, *Sorghum bicolor*, *Hordeum vulgare* (two and five rowed barley) and *x Triticosecale*; seeds of Canola (*B. campestris*) and oilseed rape (*B. napus*); seeds of sunflower (*Helianthus annuus*); seeds of linseed (*linum usitatissimum*); seeds of cotton (*Gossypium hirsutum*); and seeds of soya bean (*Glycine max*).

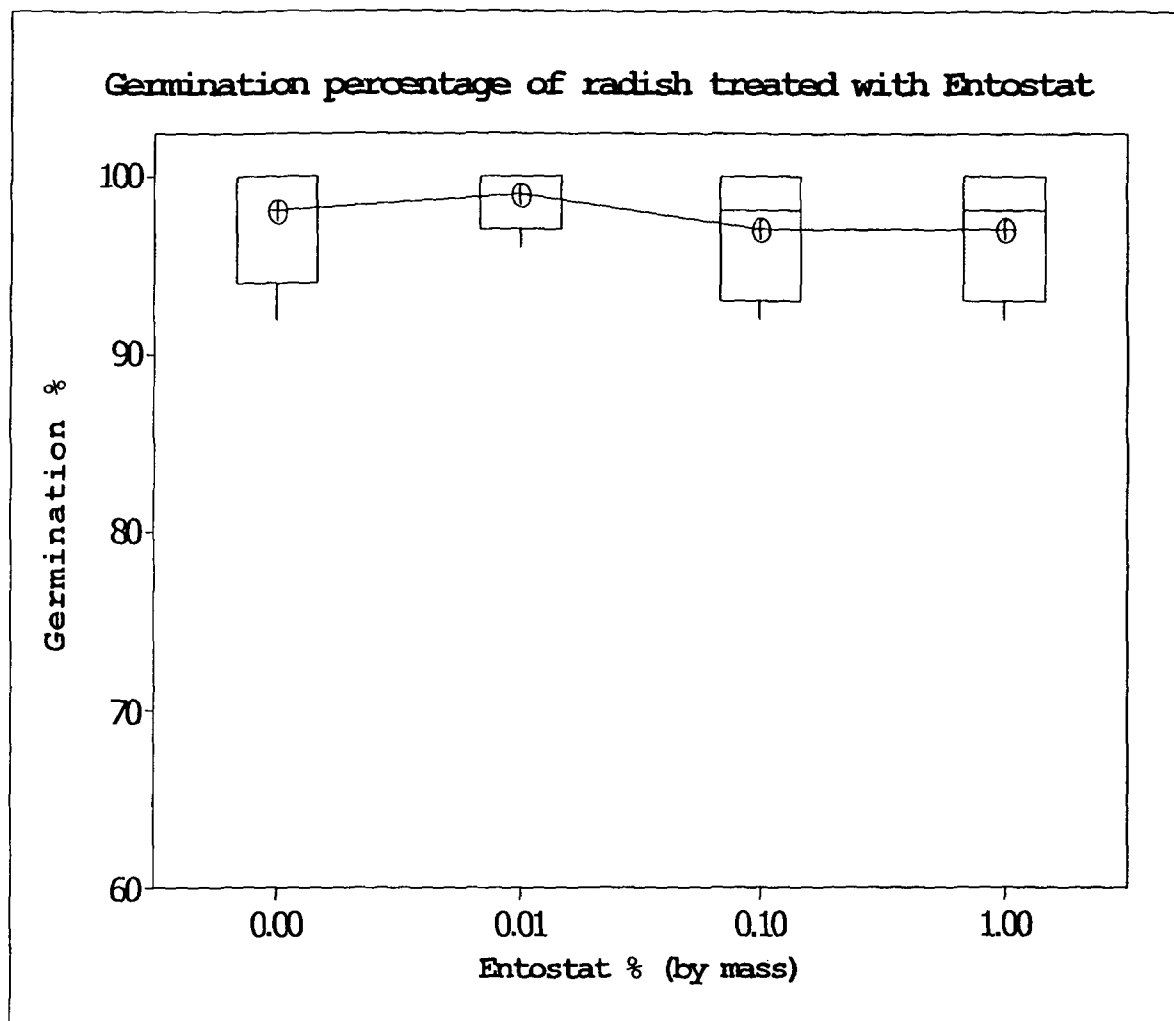


FIGURE 1

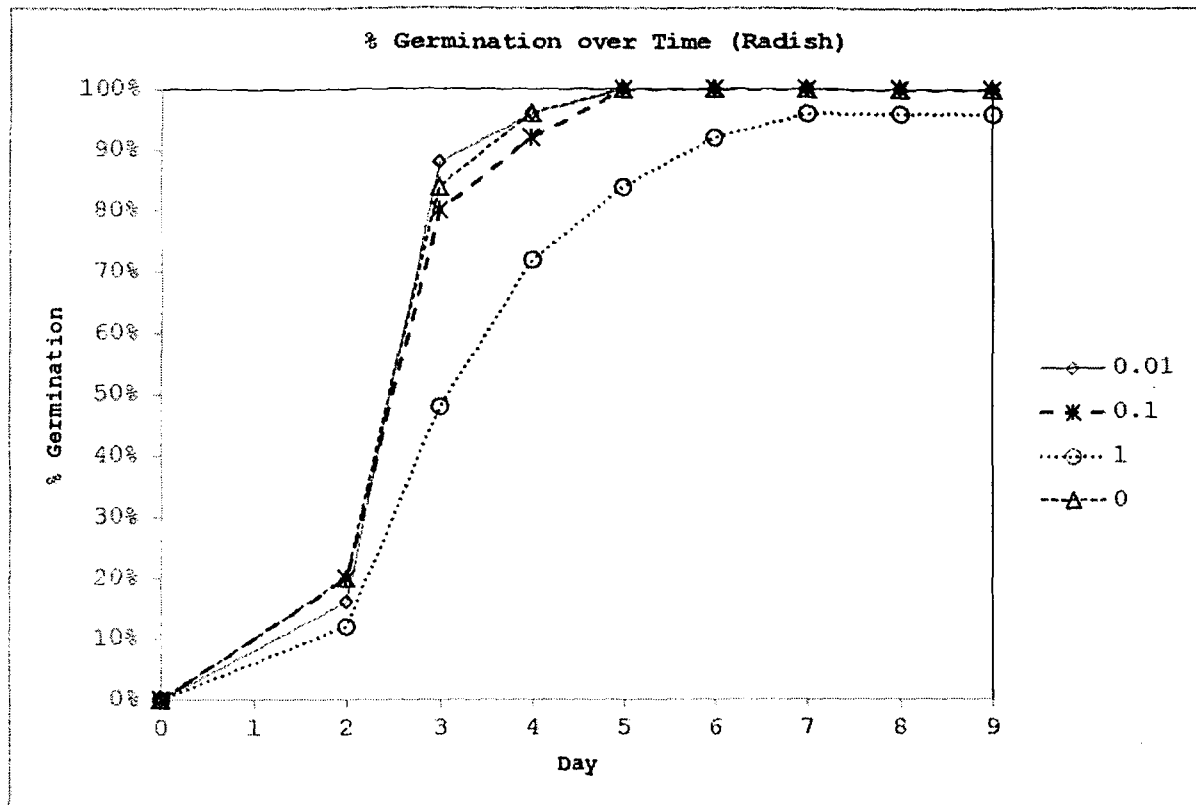


FIGURE 2