

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property

Organization

International Bureau

(43) International Publication Date

17 December 2020 (17.12.2020)



(10) International Publication Number

WO 2020/249393 A1

(51) International Patent Classification:

A01N 25/04 (2006.01)

G01N 21/00 (2006.01)

G01N 13/00 (2006.01)

G01N 33/00 (2006.01)

Published:

— with international search report (Art. 21(3))

(21) International Application Number:

PCT/EP2020/064571

(22) International Filing Date:

26 May 2020 (26.05.2020)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

1908463.1

13 June 2019 (13.06.2019)

GB

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(81) Designated States (unless otherwise indicated, for every

kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every

kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- of inventorship (Rule 4.17(iv))

(54) Title: MEASURING SPRAY DEPOSITS ON PLANT SURFACES

(57) Abstract: Method for determining the extent of deposition of a composition on the surface of a plant, the method comprising the steps of: generating an image of a surface of a plant that has been sprayed with a composition comprising a plurality of insoluble pigment particles, wherein the volume density of pigment particles in the composition is known; determining the number of pigment particles in at least a portion of the image; and calculating the extent of deposition of the composition on at least a portion of the surface using the volume density of pigment particles.



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Measuring Spray Deposits on Plant Surfaces

The present invention relates to measuring spray deposits on plant surfaces. In particular the present invention relates to a method of determining the extent of deposition of a composition (for example a volume of a spray solution) deposited on a plant surface when sprayed with a liquid such as an agrochemical. It also relates to an apparatus for determining the extent of deposition of a composition on the surface of a plant.

In agriculture, spraying is commonly used to apply various agrochemical products on or around crops or to control weeds in unplanted areas. Spraying is usually carried out using tractor-mounted spray equipment but may also be carried out using backpack type sprayers or from aircraft, including drones. The products are commonly pesticides such as herbicides, insecticides or fungicides, but may also be plant growth regulators, fertiliser or mixtures of such materials.

The products generally comprise a formulation of one or more biologically active material, such as a herbicide or fungicide, dissolved or dispersed in a liquid carrier, which is most commonly water with minor amounts of organic solvents. The formulation typically also comprises various dispersants, surfactants and other adjuvants to improve the biological activity of the product.

In the field the product has to be directed towards a target to be biologically active, i.e. to control a pest or protect or stimulate a crop. Each droplet not reaching the target is lost for efficacy, increases operator exposure risk and environmental risk potential. Maximising efficacy and safety in the field means maximising the amount of product reaching the target by optimizing application quality including spray conditions, such as spray volume per ha, spray pressures, nozzle types and speed of travel, crop stage and determining tolerance of maximal wind velocity. To do this it is important to be able to determine how much product has actually reached the target and landed on plant surfaces where it can exert its biological effect.

US 5,900,944 describes a method of determining the amount of pesticidal seed coating composition that has adhered to seeds when they have been treated. The method involves including a known quantity of a fluorescent pigment in a pesticide formulation and using a measurement of the light reflected from a coated surface such as seeds, to calculate the amount of composition that has adhered to the surface.

A problem with using light reflection in this manner is that relatively high concentrations of pigment are required in order to enable accurate measurement at conventional application rates. This may not be a problem with seed coating in which relatively high concentrations of pesticidal composition are applied to seed surfaces under factory conditions but when
5 scaled up to spraying fields of crops, an unrealistic amount of pigment is required to give sufficient light reflection for accurate measurement.

A further problem is that the measurement obtained is necessarily an aggregate across the illuminated area and there is no opportunity of looking at a variation or gradient in the
10 distribution within a given area, for example between the base and tip of a leaf.

According to a first aspect of the present invention there is provided a method for determining the extent of deposition of a composition on the surface of a plant, the method comprising the steps of;

15 generating an image of a surface of a plant that has been sprayed with a composition comprising a plurality of insoluble pigment particles, wherein the volume density of pigment particles in the composition is known;

 determining the number of pigment particles in at least a portion of the image; and

20 calculating the extent of deposition of the composition on at least a portion of the surface using the volume density of pigment particles.

Aptly, the method is for determining the extent of deposition of an agrochemical on the surface of a plant. That is, the composition comprises an agrochemical and wherein
25 calculating the extent of deposition of the composition includes calculating an extent of deposition of the agrochemical on the at least a portion of the surface. In other words, there is provided a method for determining the extent of deposition of an agrochemical on the surface of a plant, the method comprising the steps of;

 generating an image of a surface of a plant that has been sprayed with a
30 composition comprising an agrochemical and a plurality of insoluble pigment particles, wherein the volume density of pigment particles in the composition is known;

 determining the number of pigment particles in at least a portion of the image; and

35 calculating the extent of deposition of the agrochemical on at least a portion of the surface using the volume density of pigment particles.

Aptly, the method is for predicting the extent of deposition of an agrochemical on the surface of a plant. That is, the method further includes the step of calculating a predicted extent of deposition of an agrochemical using the calculated extent of deposition of the composition. In other words, there is provided a method for predicting the extent of deposition of an agrochemical on the surface of a plant, the method comprising the steps of;

- 5 generating an image of a surface of a plant that has been sprayed with a composition comprising a plurality of insoluble pigment particles, wherein the volume density of pigment particles in the composition is known;
- determining the number of pigment particles in at least a portion of the image;
- 10 and
- calculating the extent of deposition of the composition on at least a portion of the surface using the volume density of pigment particles; and
- calculating a predicted extent of deposition of an agrochemical using the calculated extent of deposition of the composition.

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Aptly, the extent of deposition of the composition is a volume of composition deposited on the at least a portion of the surface and/or a volume of composition deposited on the at least a portion of the surface per unit area. Aptly, the extent of deposition of the agrochemical is a volume of agrochemical deposited on the at least a portion of the surface and/or a volume of agrochemical deposited on the at least a portion of the surface per unit area.

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Aptly, the method further comprises the step of determining the volume density of pigment particles in the composition.

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Aptly, the method comprises the step of illuminating the surface of the plant with a light source during the generation of the image of the surface.

Aptly, the pigment particles are luminescent particles, such that the illumination of the surface, during generation of the image of the surface, causes individual pigment particles to luminesce.

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Aptly, the surface of the plant is within a housing while the image is generated.

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Aptly, the method further comprises the step of drying the surface of the plant prior to generation of the image.

Aptly, the pigment particles have a particle size of less than 10 μ m.

Aptly, the surface of the plant comprises at least one of the upper and lower surfaces of a plant leaf, and/or the stem of a plant, and/or the flower.

- 5 Aptly, the volume density of pigment particles in the composition is between 50 and 200 particles / μl .

According to a further aspect of the present invention there is provided an apparatus for determining or predicting the extent of deposition of an agrochemical on the surface of a
10 plant, wherein the apparatus comprises;

an imaging apparatus for generating an image of a surface of a plant that has been sprayed with a composition, wherein the composition comprises a plurality of insoluble pigment particles, wherein the volume density of pigment particles in the composition is known; and

15 processing means configured to:

determine the number of pigment particles in at least a portion of the image; and

determine the extent of deposition of the composition on at least a portion of the surface using the volume density of pigment particles.

20

Aptly, the apparatus further comprises a light source for illuminating the surface.

Aptly, the apparatus further comprises a housing for housing the plant while the image is generated.

25

Aptly, the apparatus further comprises a memory to store the image of the surface.

Certain aspects of the present invention provide a method for determining the extent of deposition of a composition on the surface of a plant that overcomes the above problems.

- 30 In particular, the inventors have advantageously found that determining the extent of deposition by determining the number of particles, rather than the prior art methods of measuring reflected light, results in a more accurate measurement of pigment concentration and, by simple calculation, the amount of composition (for example the deposit volume). The use of luminescent pigment particles has been found to allow for particularly efficient
35 determination of the particles (i.e. it allows for easy identification thereof).

Certain aspects of the present invention provide a method for determining the extent of deposition of a composition on the surface of a plant that is effective for small amounts of composition. That is, the method is highly sensitive for determining small deposit volumes even with a small number of pigment particles, which allows to detect accurately the extent of deposition of any spray ingredient, for example an agrochemical. The extent of deposition of the composition may include a calculation of the extent of deposition of an agrochemical (if present in the composition). Alternatively, the extent of deposition of the composition may be used to estimate an extent of deposition of an agrochemical if an agrochemical were to be included in the composition.

Throughout the specification the term “agrochemical” is used to encompass a wide variety of herbicides, fungicides, insecticides, plant growth regulators and other chemicals which control or kill pests or which influence the growth processes of plants. A large number of commercial agrochemicals are listed in The Pesticide Manual published online by the British Crop Protection Council and which will be very familiar to those in the agrochemical field.

Throughout the specification reference is made to a “plant”. “Plants” encompasses both useful plants such as crops and unwanted plants such as weeds. Large numbers of both crops and weeds will be familiar to those in the agrochemical field. Examples of plants include crops such as cereals, for example barley and wheat, cotton, oilseed rape, sunflower, maize, rice, soybeans, sugar beet, sugar cane and potato. Crop plants can also include trees, such as fruit trees, palm trees, coconut trees or other nuts. Also included are vines such as grapes, fruit bushes, fruit plants and vegetables. Other useful plants include turf grass for example in golf-courses, lawns, parks and roadsides, or grown commercially for sod, and ornamental plants such as flowers or bushes. Examples of plants also include monocotyledonous and dicotyledonous weed species. Examples of monocotyledonous species include *Alopecurus myosuroides*, *Avena fatua*, *Brachiaria plantaginea*, *Bromus tectorum*, *Cyperus esculentus*, *Digitaria sanguinalis*, *Echinochloa crus-galli*, *Lolium perenne*, *Lolium multiflorum*, *Panicum miliaceum*, *Poa annua*, *Setaria viridis*, *Setaria faberi* and *Sorghum bicolor*. Examples of dicotyledonous weed species include *Abutilon theophrasti*, *Amaranthus retroflexus*, *Bidens pilosa*, *Chenopodium album*, *Euphorbia heterophylla*, *Galium aparine*, *Ipomoea hederacea*, *Kochia scoparia*, *Polygonum convolvulus*, *Sida spinosa*, *Sinapis arvensis*, *Solanum nigrum*, *Stellaria media*, *Veronica persica* and *Xanthium strumarium*.

The term “spray application” refers to any method that results in droplets of the composition being aeri ally distributed on or near the plant. Sprays can be mechanically driven, such as

tractor mounted equipment, or can be manually operated such as knapsack sprayers. The expression "on or near the plant" refers to the area which is in sufficient proximity to the spray output for the spray to have potentially landed on it. Aptly, this includes target plants deliberately sprayed, but also may include other plants, for example at the margins of a field, or even an adjacent field where there is an interest in determining whether any composition (and optionally an agrochemical within the composition) is present on the plant after spraying.

Throughout the specification reference is made to a "volume density". It would be understood that a volume density of a parameter is a concentration of the parameter within a volume. For example, a volume density of particles relates to the number of particles within a unit volume, otherwise termed the concentration of particles within a volume.

Throughout the specification reference is made to the "extent of deposition". This expression is intended to refer to a measure of composition deposited on the corresponding surface (i.e. a deposit volume on a corresponding surface). In examples, the extent of deposition refers to a volume (for example a spray volume) or amount of composition (and optionally an agrochemical within the composition) deposited on the surface (or a portion thereof) and/or the volume per area of composition (and optionally an agrochemical within the composition) deposited on the surface (or a portion thereof) and/or the weight, or weight per area of composition (and optionally an agrochemical within the composition) deposited on the surface (or a portion thereof). The extent of deposition of the composition may be used to determine the amount of any constituent ingredient of the composition, for example an agrochemical, deposited on the surface (or a portion thereof) and/or the weight, or weight per area.

Throughout the specification reference is made to "calculating the extent of deposition". It would be understood that the calculated extent of deposition is an approximation to some degree. That is, the volume density of particles within the composition as tested or commercially provided is used as a proxy for the volume density of particles within the composition as deposited on a surface. In other words it is assumed that the volume density of particles deposited on the surface is reflective of the known volume density in the tested/provided composition. In practice there may be minor deviations between these.

Examples of the present invention will now be described hereinafter, by way of example only, with reference to the accompanying drawings in which:

Fig. 1 demonstrates a method of determining the extent of deposition of a composition deposited on a surface of a plant;

Fig. 2 demonstrates another example of a method of determining the extent of deposition of a composition deposited on a surface of a plant;

5 Fig. 3 demonstrates an example apparatus for determining the extent of deposition of a composition on the surface of a plant; and

Fig. 4 demonstrates a cross sectional view of the apparatus of Fig. 3.

In the drawings like reference numerals refer to like parts.

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Fig. 1 details an example of a method for determining the extent of deposition of a composition on the surface of a plant, in particular a spray deposit. As described above, the plant may be any plant found in agriculture, for example a crop or a weed. The surface of the plant may be a leaf, stem, bud or any other part of the plant. In some examples the extent of deposition may be measured on only one surface of the plant, for example the upper surface of a leaf. In other examples the extent of deposition on a plurality of surfaces of the plant may be measured, for example both the upper and lower surfaces of a leaf.

20 The composition includes a plurality of insoluble pigment particles. Aside from the presence of the pigment particles, the composition may be any composition suitable for spray application. For example, the composition may include the plurality of insoluble pigment particles and a liquid or solid carrier and optionally minor amounts of organic solvent.

25 The liquid carrier or carriers may be chosen from, for example, water (or predominantly water), toluene, xylene, petroleum ether, vegetable oils, acetone, methyl ethyl ketone, cyclohexanone, acid anhydrides, acetonitrile, acetophenone, amyl acetate, 2-butanone, butylene carbonate, chlorobenzene, cyclohexane, cyclohexanol, alkyl esters of acetic acid, diacetone alcohol, 1,2-dichloropropane, diethanolamine, p-diethylbenzene, diethylene glycol, diethylene glycol abietate, diethylene glycol butyl ether, diethylene glycol ethyl ether, diethylene glycol methyl ether, N,N-dimethyl-formamide, dimethyl sulfoxide, 1,4-dioxane, dipropylene glycol, dipropylene glycol methyl ether, dipropylene glycol dibenzoate, diproxitol, alkylpyrrolidone, ethyl acetate, 2-ethyl-hexanol, ethylene carbonate, 1,1,1-trichloroethane, 2-heptanone, alpha-pinene, d-limonene, ethyl lactate, ethylene glycol, ethylene glycol butyl ether, ethylene glycol methyl ether, gamma-butyrolactone, glycerol, glycerol acetate, glycerol diacetate, glycerol triacetate, hexadecane, hexylene glycol, isoamyl acetate, isobornyl acetate, isooctane, isophorone, isopropylbenzene, isopropyl myristate, lactic acid, laurylamine, mesityl oxide, methoxy-propanol, methyl isoamyl ketone,

methyl isobutyl ketone, methyl laurate, methyl octanoate, methyl oleate, methylene chloride, m-xylene, n-hexane, n-octylamine, octa-decanoic acid, octylamine acetate, oleic acid, oleylamine, o-xylene, phenol, polyethylene glycol, propionic acid, propyl lactate, propylene carbonate, propylene glycol, propylene glycol methyl ether, p-xylene, toluene, triethyl phosphate, triethylene glycol, xylenesulfonic acid, paraffin, mineral oil, trichloroethylene, perchloroethylene, ethyl acetate, amyl acetate, butyl acetate, propylene glycol methyl ether, diethylene glycol methyl ether, methanol, ethanol, isopropanol, and alcohols of higher molecular weight, such as amyl alcohol, tetrahydro-furfuryl alcohol, hexanol, octanol, ethylene glycol, propylene glycol, glycerol, N-methyl-2-pyrrolidone and the like. The solid carrier or carriers may be chosen from, for example, talc, titanium dioxide, pyrophyllite clay, silica, attapulgite clay, kieselguhr, limestone, calcium carbonate, bentonite, calcium montmorillonite, cottonseed husks, wheat flour, soybean flour, pumice, wood flour, ground walnut shells, lignin and similar substances.

In other examples, the composition may include an agrochemical. That is, the composition may include a formulation of one or more biologically active material, such as a herbicide or fungicide. The agrochemical may be dissolved or dispersed in a liquid carrier, or the agrochemical may replace the liquid carrier (that is, a liquid agrochemical may be used as a carrier for the plurality of insoluble pigment particles).

The agrochemical (i.e. the active material) may be contained in micro-capsules, for example very fine micro-capsules. The microcapsules may contain the active ingredients in a porous carrier. This enables the active ingredients to be released into the environment in controlled amounts (e.g. slow-release). In examples, the microcapsules may have a diameter of from 0.1 to 500 microns. In examples, the microcapsules may contain active ingredients in an amount of about from 25 to 95 % by weight of the capsule weight. The encapsulating membranes may comprise, for example, natural or synthetic rubbers, cellulose, styrene/butadiene copolymers, polyacrylonitrile, polyacrylate, polyesters, polyamides, polyureas, polyurethane or chemically modified polymers and starch xanthates or other polymers that are known to the person skilled in the art. Alternatively, very fine microcapsules may be formed in which the active ingredient is contained in the form of finely divided particles in a solid matrix of base substance, but the microcapsules are not themselves encapsulated. In other examples, the agrochemical may be in the form of a monolithic solid, in the form of fine particles in solid or liquid dispersion or in the form of a suitable solution.

The composition may be used as an agent in unmodified form, although aptly, the composition may also include various other components or adjuvants to improve their storage stability or biological performance such as carriers, solvents, surface-active substances, surfactants, stabilisers, dispersants, wetters or stickers. For example the composition may include a surfactant that helps produce a homogeneous dispersion of the pigment particles. For example a SC010 formulation of Lumogen as a stock solution may be used. A generally homogeneous dispersion of pigment particles helps produce an accurate result in determining the extent of deposition. The composition may generally comprise from 0.1 to 99 % by weight, especially from 0.1 to 95 % by weight, of compounds of the present invention and from 1 to 99.9 % by weight of a formulation adjuvant which preferably includes from 0 to 25 % by weight of a surface-active substance. Whereas commercial products may preferably be formulated as concentrates, the end user will normally employ dilute formulations.

The formulation adjuvants that are suitable for the preparation of the compositions are known per se. Further adjuvants that may be used in agrochemical formulations include crystallisation inhibitors, viscosity modifiers, suspending agents, dyes, anti-oxidants, foaming agents, light absorbers, mixing auxiliaries, antifoams, complexing agents, neutralising or pH-modifying substances and buffers, corrosion inhibitors, fragrances, wetting agents, take-up enhancers, micro-nutrients, plasticisers, glidants, lubricants, dispersants, thickeners, antifreezes, microbicides, and liquid and solid fertilisers.

A large number of surface-active substances may advantageously be used in both solid and liquid formulations, especially in those formulations which can be diluted with a carrier prior to use. Surface-active substances may be anionic, cationic, non-ionic or polymeric and they can be used as emulsifiers, wetting agents or suspending agents or for other purposes. Typical surface-active substances include, for example, salts of alkyl sulfates, such as diethanolammonium lauryl sulfate; salts of alkylarylsulfonates, such as calcium dodecylbenzenesulfonate; alkylphenol/alkylene oxide addition products, such as nonylphenol ethoxylate; alcohol/alkylene oxide addition products, such as tridecylalcohol ethoxylate; soaps, such as sodium stearate; salts of alkylnaphthalenesulfonates, such as sodium dibutylnaphthalenesulfonate; dialkyl esters of sulfosuccinate salts, such as sodium di(2-ethylhexyl)sulfosuccinate; sorbitol esters, such as sorbitol oleate; quaternary amines, such as lauryltrimethylammonium chloride, polyethylene glycol esters of fatty acids, such as polyethylene glycol stearate; block copolymers of ethylene oxide and propylene oxide; and salts of mono and di-alkylphosphate esters; and also further substances described e.g. in

McCutcheon's Detergents and Emulsifiers Annual, MC Publishing Corp., Ridgewood New Jersey (1981).

5 The composition may be of a formulation type including, for example, an emulsion concentrate (EC), a suspension concentrate (SC), a suspo-emulsion (SE), a capsule suspension (CS), a water dispersible granule (WG), an emulsifiable granule (EG), an emulsion, water in oil (EO), an emulsion, oil in water (EW), a micro-emulsion (ME), an oil dispersion (OD), an oil miscible flowable (OF), an oil miscible liquid (OL), a soluble concentrate (SL), an ultra-low volume suspension (SU), an ultra-low volume liquid (UL), a
10 technical concentrate (TK), a dispersible concentrate (DC), a wettable powder (WP), a soluble granule (SG) or any technically feasible formulation in combination with agriculturally acceptable adjuvants.

15 The composition may be in various physical forms, for example in the form of dusting powders, gels, wettable powders, water-dispersible granules, water-dispersible tablets, effervescent pellets, emulsifiable concentrates, micro-emulsifiable concentrates, oil-in-water emulsions, oil-flowables, aqueous dispersions, oily dispersions, suspo-emulsions, capsule suspensions, emulsifiable granules, soluble liquids, water-soluble concentrates (with water or a water-miscible organic solvent as carrier), impregnated polymer films or in other forms
20 known e.g. from the Manual on Development and Use of FAO and WHO Specifications for Pesticides, United Nations, First Edition, Second Revision (2010). Such formulations may be used directly or diluted prior to use. The dilutions may be made, for example, with water, pesticides solutions, liquid fertilisers, micronutrients, biological organisms, oil or solvents.

25 The compositions may include an additive comprising an oil of vegetable or animal origin, a mineral oil, alkyl esters of such oils or mixtures of such oils and oil derivatives. The amount of oil additive in the composition according to the invention is generally from 0.01 to 10 %, based on the mixture to be applied. For example, the oil additive can be added to a spray tank in the desired concentration after a spray mixture has been prepared. Preferred oil
30 additives comprise mineral oils or an oil of vegetable origin, for example rapeseed oil, olive oil or sunflower oil, emulsified vegetable oil, alkyl esters of oils of vegetable origin, for example the methyl derivatives, or an oil of animal origin, such as fish oil or beef tallow. Preferred oil additives comprise alkyl esters of C8-C22 fatty acids, especially the methyl derivatives of C12-C18 fatty acids, for example the methyl esters of lauric acid, palmitic acid
35 and oleic acid (methyl laurate, methyl palmitate and methyl oleate, respectively). Many oil derivatives are known from the Compendium of Herbicide Adjuvants, 10th Edition, Southern Illinois University, 2010.

The composition may be prepared in any suitable manner, for example by mixing the active ingredient with the formulation adjuvants in order to obtain a composition in the form of finely divided solids, granules, solutions, dispersions or emulsions. The active ingredients can also
5 be formulated with other adjuvants, such as finely divided solids, mineral oils, oils of vegetable or animal origin, modified oils of vegetable or animal origin, organic solvents, water, surface-active substances or combinations thereof.

The pigment particles are insoluble either as a result of the pigment itself being insoluble, or
10 due to the encapsulation of the pigment within an insoluble medium (for example a microsphere) or coating of the pigment with an insoluble medium. In some examples the pigment is biologically degradable. The pigment particles may have a particle size of 1 to 25 μm , aptly less than 10 μm , more aptly less than 8 μm .

15 In this method the volume density of the pigment particles within the composition is known. That is, the volume density of pigment particles within the composition is known prior to the subsequent steps in determining the extent of deposition of the composition on the surface of the plant. The volume density of pigment particles may be pre-determined as a result of the composition being commercially sourced (i.e. with information of the constituent
20 components provided). Alternatively, the volume density of pigment may be known due to being calculated, either prior to the steps of the method or as part of the method itself (as described later). The known composition may be input by a user during the subsequently described method steps, or alternatively may be stored in a memory of a processing means and is recalled when required.

25

The composition typically includes 50-200 pigment particles / μl . Particles within the composition are typically 0.5-2 g particles per hectare at 1-10 parts per billion (w/v).

It would be understood that the specifics of the spray application of the plant with
30 composition is unimportant to the described method. Any spray application techniques known in the art may be used. For example, the composition may be sprayed onto the plant with an application rate of 20 to 1000 litres per hectare (l/ha), however the rates of application vary within wide limits and depend on the nature of the soil, the method of application, the crop plant, the pest to be controlled, the prevailing climatic conditions, and other factors
35 governed by the method of application, the time of application and the target crop. As a general guideline compounds may be applied at a rate of from 1 to 2000 l/ha, especially

from 10 to 1000 l/ha.. Aptly, before application the composition should be stirred or otherwise mixed to help ensure a homogenous distribution of particles in the solution.

5 The method includes the step 102 of generating an image of the surface of the plant (or the plurality of surfaces) that has been sprayed with the composition.

In this example the image of the surface of a plant that has been sprayed with the composition is generated using an imaging apparatus, for example a camera. That is, during generation of the image, the field of view of the imaging apparatus includes a least a portion
10 of the surface of the plant and an image is generated thereof. The field of view of the imaging apparatus may be made to include to the plant in any suitable manner. For example, the imaging apparatus may have a fixed field of view, within which the plant is located, or the imaging apparatus may be moved until its field of view includes the plant.

15 The method further includes the step 104 of determining the number of pigment particles in the image (or a portion thereof). For example, determination of the number of pigment particles in the image may include identification of pigment particles within the image and counting the number of identified pigment particles.

20 In the most general sense, the determination of the number of pigment particles in the image may involve manually counting the number of pigment particles in the image (for example when using pigment particles that are visible to the human eye or that luminesce to become visible to the human eye). In other examples, the step of determining the number of pigment particles may be undertaken by processing means. For example, the processing means may
25 include image processing means, for example a processor with image processing software, that can be used to identify pigment particles present in the image and then count the number of pigment particles present (i.e. by counting the number of identified 'dots' in the generated image). An example of suitable software is ImageJ. ImageJ is a Java-based image processing program developed at the National Institutes of Health and the Laboratory
30 for Optical and Computational Instrumentation (LOCI, University of Wisconsin).

The method further includes the step 106 of calculating the extent of deposition of the composition on at least a portion of the surface using the volume density of pigment particles.

35

The extent of deposition may be the volume of composition deposited on the imaged surface (i.e. the portion of the surface present in the image). In other words, the number of pigment

particles, N, deposited on the imaged surface and the volume density, P, of pigment particles within the composition (i.e. number of particles per unit volume) allows the volume of composition deposited on the imaged surface to be calculated. In such examples, the volume, V, of composition deposited on the imaged surface (or portion thereof) may be
5 calculated as follows:

$$V = N / P$$

The extent of deposition may alternatively (or additionally) be the volume of composition deposited on the imaged surface per unit area. In such examples, the volume of composition
10 deposited on the imaged surface per unit area will be V / A , where A is the area of the imaged surface (or, if applicable, the portion of the image in which the number of pigments particles has been determined). Calculating the extent of deposition as a volume per area of composition deposited, allows for extrapolation across the entire surface of the plant (not just the imaged portion of the surface) – for example the volume per area can be used to
15 provide an estimate of the extent of deposition across the entire surface of the plant. The area of the imaged surface may be determined in any suitable way. For example, the area of the imaged surface may be determined by processing means using image processing software (for example the same processing means/software as used to determine the number of pigment particles in the image and/or to calculate the extent of deposition of the
20 composition).

In some examples, calculating the extent of deposition of the composition may include calculating an extent of deposition of the agrochemical on the at least a portion of the surface. That is, in examples where the composition includes an agrochemical, the extent
25 of deposition of the agrochemical on the surface may be calculated. For example, if the composition substantially includes only an agrochemical and the plurality of pigments particles (i.e. without an additional liquid carrier or other constituents) the extent of deposition of the agrochemical on the surface will correspond (i.e. substantially equate) to the extent of deposition of composition. In other examples a further step of calculation may be required
30 to calculate the extent of deposition of the agrochemical. That is, the extent of deposition of the agrochemical on the surface may be calculated using the calculated extent of deposition of the general composition.

For example, for a calculated volume of composition V, a known volume density or
35 concentration, Q, of the agrochemical within the composition may be used to calculate a volume of agrochemical, V_A :

$$V_A = V Q$$

The calculation of the extent of deposition of both the composition and the agrochemical within the composition may be undertaken in a single calculation using the determined number of particles:

5
$$V_A = (N / P) Q$$

If required, the extent of deposition of the agrochemical may also include the weight of the agrochemical deposited on the imaged surface. For example, if the concentration (by weight), C of the agrochemical in the composition is known (for example in grams per litre (g/l)) then the ratio R between the number of particles and the weight of agrochemical (i.e. the number of particles per unit weight of agrochemical) can be calculated as:

$$R = P / C$$

This ratio, the area of the imaged surface, A, and the number of pigment particles, N, deposited on the area allows the weight, w, of agrochemical deposited per unit area of the surface to be calculated:

15
$$w = N / (A \times R)$$

In examples where the composition does not include an agrochemical, the extent of deposition of an agrochemical, if it were to be present in the composition, can be predicted using the calculated extent of deposition of the composition. In other words, the calculated extent of deposition of a composition without an agrochemical can be used as a proxy for an extent of deposition of an agrochemical, if it were to be present in the composition. This is particularly useful in trial / testing situations, for example testing and subsequently optimising the efficiency of spraying techniques or testing conditions for spraying. In particular, this allows for maximising the efficacy of the applied products while minimising the quantity applied and ensuring safe operating conditions. Such tests can be undertaken without the use of an agrochemical and used as a proxy for predicting the performance, efficacy and safety of commercial operations.

30 For example, a predicted extent of deposition of an agrochemical may be calculated as substantially equating to the calculated extent of deposition the composition (for example, if the agrochemical were to replace the liquid carrier in the composition). In other examples, an intended concentration of agrochemical within the composition may be used to calculate a predicted extent of deposition of the agrochemical from the calculated extent of deposition of the composition, in the same manner as described above.

35

In some examples, the pigment particles may be chosen so as to luminesce upon excitation by light of certain wavelengths (i.e. the pigment particles are luminescent particles, or more aptly, the pigment particles are photoluminescent or fluorescent particles). In this manner, illumination of the surface during generation of the image of the surface causes individual pigment particles to luminesce (which is therefore captured in the generated image). Such luminescence may assist during the determination of the number of pigment particles (for example, the luminescence may help during identification of the pigment particles).

Fig. 2 illustrates an example method for determining the extent of deposition of a composition on the surface of a plant when using such pigment particles. The method of Fig. 2 includes the same steps 102, 104 and 106 as per the method of Fig. 1. The method of Fig. 2 includes the additional step 108 of illuminating the surface of the plant with a light source during the generation of the image of the surface.

Illuminating the surface during generation of the image of the surface may make individual pigment particles in the image clearer and hence help with the identification of the individual pigment particles from the image. In some examples, the illumination may be provided so as to cause the individual pigment particles to luminesce. Aptly a light source may provide light of a wavelength which corresponds with the peak excitation wavelength of the pigment. Aptly this wavelength may be between 250nm and 500 nm, and more aptly between 350nm and 400nm. In some examples natural light may cause the pigment to fluoresce and an additional light source is unnecessary. That is, an alternative to step 108 may be to illuminate the surface of the plant (i.e. without an additional light source).

Examples of suitable pigments are Lumogen Gelb S 0795 from BASF, SC-5 and SC-27 from Angstrom Technologies and blue melamine formaldehyde resin microspheres from R C Tritec Ltd. The suitable sizes and densities of the pigment particles given for the first example are also applicable for the second example.

The number of luminescing pigment particles in at least a portion of the image may be counted in the same way as described for the previous example. That is, a suitable image processing software may be used to identify and determine the number of fluorescent pigments. The extent of deposition of the composition (and optionally the extent of deposition of an agrochemical therein) on at least a portion of the surface is then calculated as per the previous example.

In some examples the images may be generated while the surface of the plant is located within a housing (otherwise termed a hood or enclosure element). That is, the plant is located within the housing while the image is generated. This provides the advantage that the luminescence / fluorescence of the particles is clearer and thereby improves the accuracy of the determination of the deposition. In examples, the surfaces being tested may be mounted onto black material to improve the contrast of the luminescence / fluorescence.

In either of the above examples, the volume density of pigment particles may be known due to having been calculated as part of the method. That is, prior to the determination the number of pigment particles in the image, the volume density of pigment particles may be calculated. In other words the method for determining the extent of deposition of an composition on the surface of a plant includes the steps of generating an image of a surface of the plant, calculating the volume density of pigment particles in the composition, determining the number of pigment particles in at least a portion of the image and calculating the extent of deposition of the composition on at least a portion of the surface using the volume density of pigment particles.

The volume density of pigment particles in the composition may be calculated in any known manner. For example, it may be calculated by taking a sample/aliquot of known volume of the composition, for example 4 µl, of the composition, and analysing the composition. For example, the sample may be spread onto an inert surface. The analysis may be undertaken using the same imaging apparatus and processing means described previously. The particles per unit volume C can be calculated using the formula:

$$C = \text{Number of particles counted/sample volume}$$

Once calculated, the volume density of pigment particles may be exported to a memory of the processing means. In some examples a plurality of samples may be analysed and an average taken.

Fig. 3 and Fig. 4 illustrate an example of an apparatus 300 for determining the extent of deposition of a composition on the surface of a plant (for example by carrying out the methods described above). In this example the apparatus 300 includes an imaging apparatus 310 for generating an image of a surface of a plant 340 that has been sprayed with a composition, where the composition includes a plurality of insoluble pigment particles and optionally an agrochemical. As discussed with regards to the corresponding methods the volume density of pigment particles in the composition is known.

In this example, the imaging apparatus 310 is a camera, for example a digital camera to generate a digital image. Aptly the camera may be a high-resolution digital camera which generates a high-resolution digital image. Images can, for example, be taken with a high-resolution camera equipped with a 1" CMOS image sensor. An example of a suitable camera is a Sony DSC RX 100 IV. In examples where the means for generating an image 310 is a camera an example camera setting is an exposure time of 0.125 sec, aperture 1.8; ISO800. The imaging apparatus 310 may have a fixed position and/or orientation within the apparatus, such that the apparatus itself is moved to bring the required plant into the field of view of the imaging apparatus 310. Alternatively, the imaging apparatus may be mounted (for example, rotatably mounted, e.g. on a gimbal) to allow it adjust its field of view in accordance with the position of the plant to be imaged.

The apparatus further includes processing means (not shown) configured to determine the number of pigment particles in at least a portion of the image and determine the extent of deposition of the composition on at least a portion of the surface using the volume density of pigment particles.

In this example, the processing means includes an image processor configured to determine the number of pigment particles in the image and a separate processor configured to determine the extent of deposition of the composition on at least a portion of the surface using the volume density of pigment particles. That is, information regarding the number of particles (and optionally also the area of the imaged surface) is sent from the image processor to the processor prior to the determination of the extent of deposition.

The image is received by the image processor from the imaging apparatus. The image may be transferred wirelessly or by any other suitable means to the image processor. The image processor determines the number of pigment particles present in the image, as described for the corresponding methods. This data is then provided to the processor configured to determine the extent of deposition of the composition on at least a portion of the surface using the volume density of pigment particles.

In other examples, the image processor and the processor are present within a single processor.

In this example, the apparatus comprises a housing 350 (otherwise termed a hood or enclosure element). In use, the surface of the plant is located within the housing 350 while the image is generated. The housing 350 blocks external light, providing increased contrast

between the luminescent particles and the surroundings. This helps improve identification of the particles.

5 The housing 350 may be any suitable shape for housing the plant while the image is being generated. In this example the housing 350 has a substantially rectangular profile with an aperture on an upper surface configured to receive the imaging apparatus 310. In other examples, the housing 350 may not have such an aperture and instead the imaging apparatus 310 may be coupled to an interior surface of the housing 350.

10 In some examples the apparatus 300 may include at least one light source for illuminating the surface. The light source may be an LED 330 or a plurality of LEDs (for example 4 LEDs). Aptly the light source may produce a light of a wavelength that is substantially equivalent to that of the pigment peak excitation wavelength. In some examples this wavelength may be in the range of 350nm to 400nm.

15

Example

Below is a worked example calculating the extent of deposition (in this example, spray deposit per area) of a composition on a surface.

5 1. Spray solution

A spray solution was made comprising water and a pigment Lumogen® Yellow S 0795 at a concentration of 5mg per litre.

2. Treatment

10 A 10 m² area of potato (variety BBCH39) plants in an open field was treated with the spray solution at an application rate of 200l/ha using a boom sprayer with hollow cone nozzles.

3. Counting the pigment Particles.

A rectangular hood was made approximately of length 30 cm equipped inside with 4 LED
15 365 nm spotlights directed towards a target area. On the top, the hood carried a Sony DSC RX 100 IV camera: the lens of the camera fitted exactly through an opening on the top.

Camera settings: exposure time of 1/8 sec, aperture 1.8; ISO 800

ImageJ was used to count dots produced by fluorescent pigments

20 4. Pigment particle concentration in the Composition

The concentration of pigment particles in the spray solution was determined by Six replicates of 4 µl aliquot of the spray solution were pipetted onto a glass plate and counted as well by the image processing program ImageJ.

25 5. Pigment Particle numbers on the Leaf Surface

Ten replicate leaves were harvested at random from the treated plants and mounted on a black cardboard and covered with a hood. Both sides of leaves were assessed

Six replicates of 4 µl aliquot of the spray solution were pipetted onto a glass plate and counted by the image processing program ImageJ.

30

6. Results

Number of pigments in spray solution $P_s / V_s = 109$ pigments particles / µl (average of 6 replicates)

Number of pigments per cm² on leaf surface (average of 10 replicate leaves)

35 Upper side $P_U / A = 27$ Pigments / cm²

Lower side $P_L / A = 2$ Pigments / cm²

Spray deposit

Upper leaf side: $V_{\text{depU}} = (P_U / A) / (P_S / V_S) = 27 / 109 \mu\text{l} / \text{cm}^2 = 0.25 \mu\text{l} / \text{cm}^2$

Lower leaf side: $V_{\text{depL}} = (P_L / A) / (P_S / V_S) = 2 / 109 \mu\text{l} / \text{cm}^2 = 0.02 \mu\text{l} / \text{cm}^2$

Upper and Lower side: $V_{\text{dep}} = (P/2 \times A) / (P_S / V_S) = (27+2)/2 / 109 \mu\text{l} / \text{cm}^2 = 0.13 \mu\text{l}/\text{cm}^2$

- 5 Nomenclature for this example (note the nomenclature may differ from that used elsewhere in the application)

P_S	Number of particles in droplet
V_S	Volume of Spray droplet
P_U	Number of pigments on upper leaf surface
A	Leaf area (cm^2)
P_L	Number of pigments on lower leaf surface
V_{depU}	Spray deposit on upper leaf surface
V_{depL}	Spray deposit on lower leaf surface
V_{dep}	Spray deposit per area

- 10 In this example the composition does not include an agrochemical. The calculated spray deposit may be used to estimate a spray deposit of an agrochemical (if an agrochemical were to be included within the composition). In other examples, the spray solution may further include an agrochemical, or include an agrochemical as a carrier for the pigment particles.

Example

Preferred formulations may have the following compositions (weight %):

Emulsifiable concentrates:

- active ingredient: 1 to 95 %, preferably 60 to 90 %
- 5 surface-active agent: 1 to 30 %, preferably 5 to 20 %
- liquid carrier: 1 to 80 %, preferably 1 to 35 %

Dusts:

- active ingredient: 0.1 to 10 %, preferably 0.1 to 5 %
- 10 solid carrier: 99.9 to 90 %, preferably 99.9 to 99 %

Suspension concentrates:

- active ingredient: 5 to 75 %, preferably 10 to 50 %
- water: 94 to 24 %, preferably 88 to 30 %
- 15 surface-active agent: 1 to 40 %, preferably 2 to 30 %

Wettable powders:

- active ingredient: 0.5 to 90 %, preferably 1 to 80 %
- surface-active agent: 0.5 to 20 %, preferably 1 to 15 %
- 20 solid carrier: 5 to 95 %, preferably 15 to 90 %

Granules:

- active ingredient: 0.1 to 30 %, preferably 0.1 to 15 %
- solid carrier: 99.5 to 70 %, preferably 97 to 85 %

25

The following Examples further illustrate, but do not limit, the invention.

<u>Wettable powders</u>	a)	b)	c)
active ingredients	25 %	50 %	75 %
sodium lignosulfonate	5 %	5 %	-
sodium lauryl sulfate	3 %	-	5 %
sodium diisobutyl naphthalenesulfonate	-	6 %	10 %
phenol polyethylene glycol ether (7-8 mol of ethylene oxide)	-	2 %	-

highly dispersed silicic acid	5 %	10 %	10 %
Kaolin	62 %	27 %	-

The combination is thoroughly mixed with the adjuvants and the mixture is thoroughly ground in a suitable mill, affording wettable powders that can be diluted with water to give suspensions of the desired concentration.

<u>Powders for dry seed treatment</u>	a)	b)	c)
active ingredients	25 %	50 %	75 %
light mineral oil	5 %	5 %	5 %
highly dispersed silicic acid	5 %	5 %	-
Kaolin	65 %	40 %	-
Talcum	-		20 %

The combination is thoroughly mixed with the adjuvants and the mixture is thoroughly ground in a suitable mill, affording powders that can be used directly for seed treatment.

5

<u>Emulsifiable concentrate</u>	
active ingredients	10 %
octylphenol polyethylene glycol ether (4-5 mol of ethylene oxide)	3 %
calcium dodecylbenzenesulfonate	3 %
castor oil polyglycol ether (35 mol of ethylene oxide)	4 %
Cyclohexanone	30 %
xylene mixture	50 %

Emulsions of any required dilution, which can be used in plant protection, can be obtained from this concentrate by dilution with water.

<u>Dusts</u>	a)	b)	c)
Active ingredients	5 %	6 %	4 %
Talcum	95 %	-	-
Kaolin	-	94 %	-

mineral filler	-	-	96 %
----------------	---	---	------

Ready-for-use dusts are obtained by mixing the combination with the carrier and grinding the mixture in a suitable mill. Such powders can also be used for dry dressings for seed.

<u>Extruder granules</u>	
Active ingredients	15 %
sodium lignosulfonate	2 %
carboxymethylcellulose	1 %
Kaolin	82 %

The combination is mixed and ground with the adjuvants, and the mixture is moistened with water. The mixture is extruded and then dried in a stream of air.

<u>Coated granules</u>	
Active ingredients	8 %
polyethylene glycol (mol. wt. 200)	3 %
Kaolin	89 %

- 5 The finely ground combination is uniformly applied, in a mixer, to the kaolin moistened with polyethylene glycol. Non-dusty coated granules are obtained in this manner.

Suspension concentrate

active ingredients	40 %
propylene glycol	10 %
nonylphenol polyethylene glycol ether (15 mol of ethylene oxide)	6 %
Sodium lignosulfonate	10 %
carboxymethylcellulose	1 %
silicone oil (in the form of a 75 % emulsion in water)	1 %
Water	32 %

The finely ground combination is intimately mixed with the adjuvants, giving a suspension concentrate from which suspensions of any desired dilution can be obtained by dilution with

water. Using such dilutions, living plants as well as plant propagation material can be treated and protected against infestation by microorganisms, by spraying, pouring or immersion.

Flowable concentrate for seed treatment

active ingredients	40 %
propylene glycol	5 %
copolymer butanol PO/EO	2 %
Tristyrenephenole with 10-20 moles EO	2 %
1,2-benzisothiazolin-3-one (in the form of a 20% solution in water)	0.5 %
monoazo-pigment calcium salt	5 %
Silicone oil (in the form of a 75 % emulsion in water)	0.2 %
Water	45.3 %

- The finely ground combination is intimately mixed with the adjuvants, giving a suspension concentrate from which suspensions of any desired dilution can be obtained by dilution with water. Using such dilutions, living plants as well as plant propagation material can be treated and protected against infestation by microorganisms, by spraying, pouring or immersion.

Slow Release Capsule Suspension

- 28 parts of the combination are mixed with 2 parts of an aromatic solvent and 7 parts of toluene diisocyanate/polymethylene-polyphenylisocyanate-mixture (8:1). This mixture is emulsified in a mixture of 1.2 parts of polyvinylalcohol, 0.05 parts of a defoamer and 51.6 parts of water until the desired particle size is achieved. To this emulsion a mixture of 2.8 parts 1,6-diaminohexane in 5.3 parts of water is added. The mixture is agitated until the polymerization reaction is completed. The obtained capsule suspension is stabilized by adding 0.25 parts of a thickener and 3 parts of a dispersing agent. The capsule suspension formulation contains 28% of the active ingredients. The medium capsule diameter is 8-15 microns. The resulting formulation is applied to seeds as an aqueous suspension in an apparatus suitable for that purpose.

Various modifications to the detailed designs as described above are possible. For example, the surface of the plant may be dried before the image is generated (i.e. after the surface of the plant has been sprayed with the composition). This may help ensure that no additional fluidic substances can interfere with results once dried.

5

The process of taking the digital image and processing this to obtain the extent of deposition of an agrochemical may be fully automated. It is possible to produce a single device comprising a light and digital camera together with a processor suitably programmed to count the particles and produce an output of the extent of deposition of an agrochemical.

10

Determination of the number of particles may be undertaken for only a portion of the area present in the image, for example only the portion of the image in which the plant is present. Similarly, the extent of deposition may be calculated for only a portion of the area present in the image. That is, in the preceding description reference to 'the image' may also be considered to include 'a portion of the image'.

15

The output of the device may be stored in a digital memory on the device for later use or printed using an inbuilt printer or displayed on a digital display. Alternatively, it may be relayed to a central collating processor for later analysis (e.g. by wires or wirelessly). Such a device may be hand-held to allow farmers or those researching agrochemical spray distribution to rapidly test for real outcomes in the field.

20

In some examples the above method is repeated a plurality of times and an average taken. In some examples, multiple portions across the surface of the same plant surface may be examined to determine the variance in the extent of deposition across a single surface of a plant. In other examples multiple portions across different plant surfaces may be examined to determine the variance in the extent of deposition on a macro scale, for example a field. In other examples a single portion of a single surface of a plant may be examined.

25

In some examples coloured particles which do not fluoresce may be used as the insoluble pigment.

30

With the above-described arrangement the information about the extent of deposition of agrochemical may be combined with locations data, for example through an inbuilt GPS system so that a concentration map of an area such as a field could be built up. Thus, the method allows both small scale analysis of the agrochemical distribution over a leaf surface and a macro scale analysis of distribution over a whole field.

35

It will be clear to a person skilled in the art that features described in relation to any of the embodiments described above can be applicable interchangeably between the different embodiments. The embodiments described above are examples to illustrate various features of the invention.

Throughout the description and claims of this specification, the words “comprise” and “contain” and variations of them mean “including but not limited to”, and they are not intended to (and do not) exclude other moieties, additives, components, integers or steps.

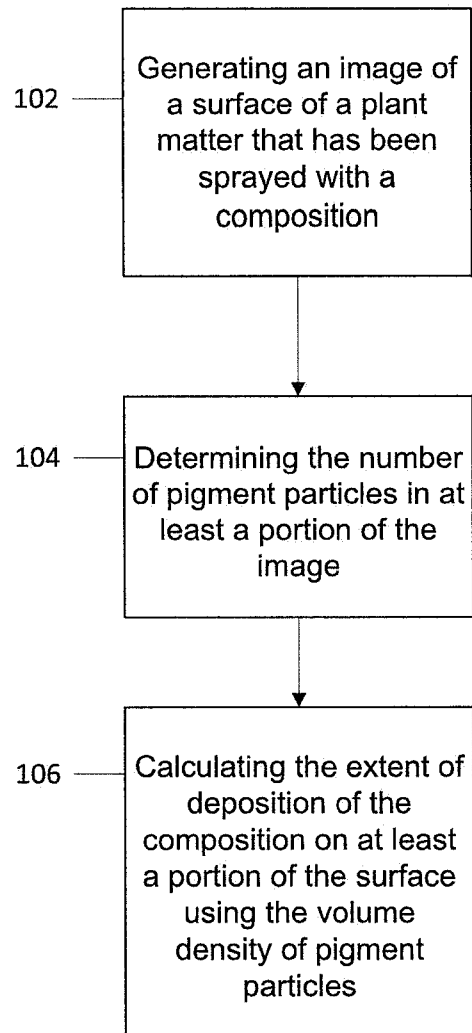
Throughout the description and claims of this specification, the singular encompasses the plural unless the context otherwise requires. In particular, where the indefinite article is used, the specification is to be understood as contemplating plurality as well as singularity, unless the context requires otherwise.

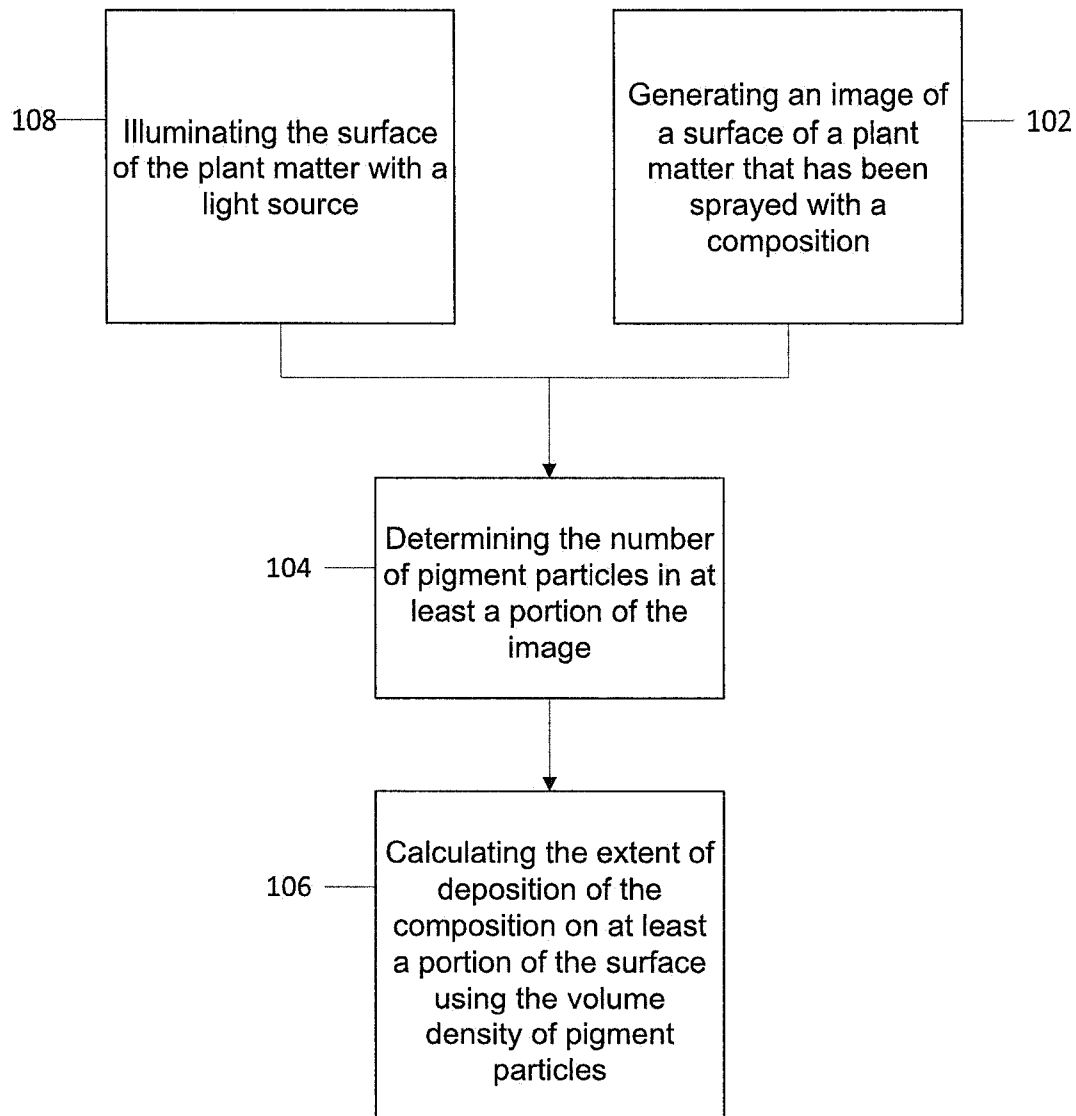
Features, integers, characteristics, compounds, chemical moieties or groups described in conjunction with a particular aspect, embodiment or example of the invention are to be understood to be applicable to any other aspect, embodiment or example described herein unless incompatible therewith. All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive. The invention is not restricted to the details of any foregoing embodiments. The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

CLAIMS

1. A method for determining the extent of deposition of a composition on the surface of a plant, the method comprising the steps of;
generating an image of a surface of a plant that has been sprayed with a
composition comprising a plurality of insoluble pigment particles, wherein the
volume density of pigment particles in the composition is known;
determining the number of pigment particles in at least a portion of the image;
and
calculating the extent of deposition of the composition on at least a portion of
the surface using the volume density of pigment particles.
2. A method according to claim 1, wherein the composition comprises an agrochemical and wherein calculating the extent of deposition of the composition includes calculating an extent of deposition of the agrochemical on the at least a portion of the surface.
3. A method according to claim 1, wherein the method further includes the step of calculating a predicted extent of deposition of an agrochemical using the calculated extent of deposition of the composition.
4. A method according to any preceding claim, wherein the extent of deposition of the composition is a volume of composition deposited on the at least a portion of the surface and/or a volume of composition deposited on the at least a portion of the surface per unit area.
5. A method according to any preceding claim, further comprising the step of determining the volume density of pigment particles in the composition.
6. A method according to any preceding claim, wherein the method comprises the step of illuminating the surface of the plant with a light source during the generation of the image of the surface.
7. A method according to claim 6, wherein the pigment particles are luminescent particles, such that the illumination of the surface, during generation of the image of the surface, causes individual pigment particles to luminesce.

8. A method according to claim 7, wherein the surface of the plant is within a housing while the image is generated.
9. A method according to any preceding claim wherein the method further comprises the step of drying the surface of the plant prior to generation of the image.
10. A method according to any preceding claim wherein the pigment particles have a particle size of less than 10 μ m.
11. A method according to any preceding claim wherein the surface of the plant comprises at least one of the upper and lower surfaces of a plant leaf, and/or the stem of a plant, and/or the flower.
12. A method according to any preceding claim wherein the volume density of pigment particles in the composition is between 50 and 200 particles / μ l.
13. An apparatus for determining the extent of deposition of a composition on the surface of a plant, wherein the apparatus comprises;
 - an imaging apparatus for generating an image of a surface of a plant that has been sprayed with a composition, wherein the composition comprises a plurality of insoluble pigment particles, wherein the volume density of pigment particles in the composition is known; and
 - processing means configured to:
 - determine the number of pigment particles in at least a portion of the image; and
 - determine the extent of deposition of the composition on at least a portion of the surface using the volume density of pigment particles.
14. An apparatus according to claim 13, wherein the apparatus further comprises a light source for illuminating the surface.
15. An apparatus according to claim 13 or 14, wherein the apparatus further comprises a housing for housing the plant while the image is generated.
16. An apparatus according to any of claims 13 to 15 wherein the apparatus further comprises a memory to store the image of the surface.

**FIG. 1**

**FIG. 2**

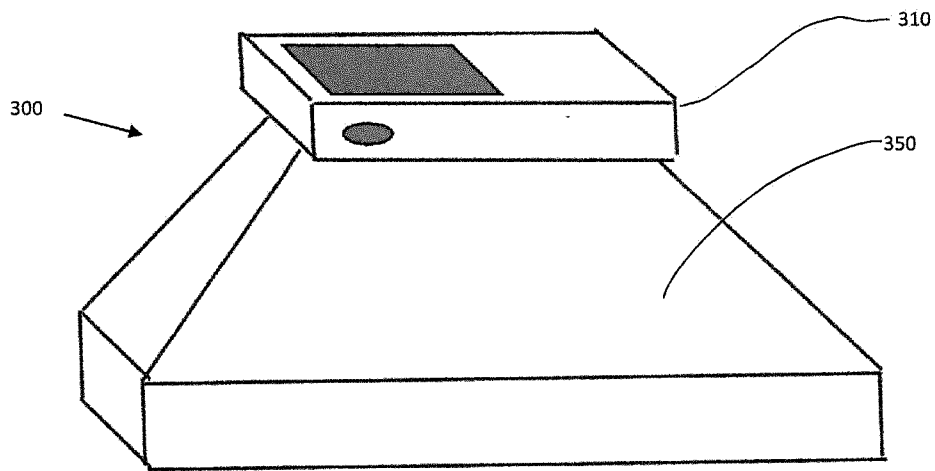


FIG. 3

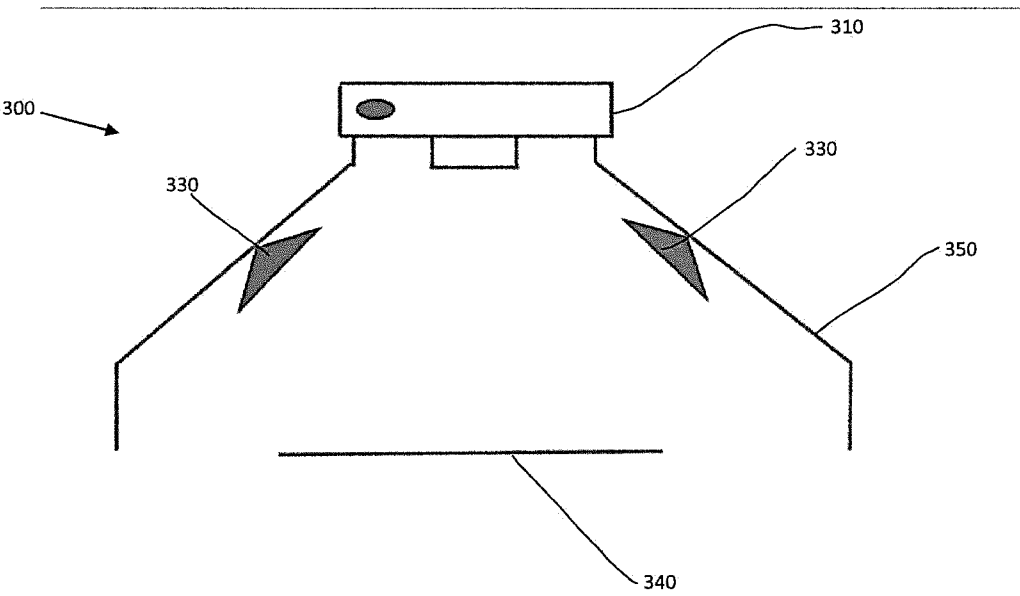


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/064571

A. CLASSIFICATION OF SUBJECT MATTER INV. A01N25/04 G01N13/00 G01N21/00 G01N33/00 ADD.		
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) A01N G01N		
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) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	J C BRINK ET AL: "Spray Deposition and Control of Botrytis cinerea on Grape Leaves and Bunches: Part 1 (Table Grapes)", SOUTH AFRICAN JOURNAL OF ENOLOGY AND VITICULTURE, vol. 37, no. 2, 1 October 2016 (2016-10-01), pages 93-103, XP55723518, "Spray application", "Image capturing and analysis"; pages 94, 95 ----- -/--	1-16
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "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 20 August 2020		Date of mailing of the international search report 28/08/2020
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Sawicki, Marcin

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/064571

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	M. D. EVANS ET AL: "Fluorescent Spray Deposit Measurement via Light Intensified Machine Vision", APPLIED ENGINEERING IN AGRICULTURE., vol. 10, no. 3, 1 January 1994 (1994-01-01), pages 441-447, XP055723507, US ISSN: 0883-8542, DOI: 10.13031/2013.25874 page 442 -----	1-16
A	CN 106 172 380 A (INST OF ENV AND SUSTAINABLE DEV IN AGRICULTURE CHINESE ACAD OF AGRICUL) 7 December 2016 (2016-12-07) paragraphs [0051] - [0058], [0104] - [0108]; figures 13-14; table 1 -----	1-16
A	JP 5 540328 B2 (NAT AGRICULTURE & FOOD RES ORG; NIPPON KAYAKU KK) 2 July 2014 (2014-07-02) paragraphs [0024], [0032] - [0033]; claims 1-7 -----	1-16

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2020/064571

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
CN 106172380	A	07-12-2016	NONE	

JP 5540328	B2	02-07-2014	JP 5540328 B2	02-07-2014
			JP 2010019835 A	28-01-2010
