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(54) Title: COMPOSITION AND METHOD FOR PROMOTING PLANT ROOT GROWTH

(57) Abstract: The present invention provides a composition comprising, as active ingredients, 4-oxo-4-[(2-phenylethyl)amino]-butyric acid and an amide compound of the formula (1); and so on.



WO 2010/137677 A1

DESCRIPTION

COMPOSITION AND METHOD FOR PROMOTING PLANT ROOT GROWTH

Technical Field

5 The present invention relates to a composition and a method for promoting root growth of plants.

Background Art

10 Conventionally, 4-oxo-4-[(2-phenylethyl)amino]-butyric acid has been known as an active ingredient for plant growth regulator (Japanese Patent No. 4,087,942). Certain amide compounds have been known as compounds which control arthropods (WO2007/043677).

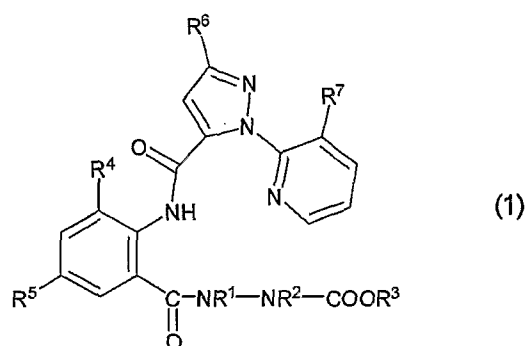
15 Disclosure of Invention

 An object of the present invention is to provide a novel composition effective in promoting root growth of plants and in controlling pests, and a method of promoting root growth of plants.

20 The present invention provides a combined application of 4-oxo-4-[(2-phenylethyl)amino]-butyric acid and a specific amide compound, the application being effective in promoting root growth of plants and controlling pests.

 Specifically, the present invention takes the following
25 constitutions:

[1] A composition comprising, as active ingredients, 4-oxo-4-[(2-phenylethyl)amino]-butyric acid and a compound of formula (1):



wherein, R^1 represents a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), R^2 represents a hydrogen atom or a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), R^3 represents a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), a C3-C6 alkoxyalkyl group optionally substituted with (a) halogen atom(s), a C3-C6 alkenyl group optionally substituted with (a) halogen atom(s) or a C3-C6 alkynyl group optionally substituted with (a) halogen atom(s), R^4 represents a halogen atom or a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), R^5 represents a hydrogen atom, a halogen atom, a cyano group or a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), R^6 represents a hydrogen atom, a halogen atom, a cyano group, a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), a C1-C6 alkoxy group optionally substituted with (a) halogen atom(s), a C1-C6 alkylthio group optionally substituted with (a) halogen atom(s), a C1-C6 alkylsulfinyl group optionally substituted with (a) halogen atom(s) or a C1-C6 alkylsulfonyl group optionally substituted with (a) halogen atom(s), and R^7 represents a halogen atom or a C1-C6 alkyl group optionally substituted with (a) halogen atom(s);

[2] A root growth promoter comprising, as active ingredients, 4-oxo-4-[(2-phenylethyl)amino]-butyric acid and a compound of formula (1) of [1];

[3] A seed treatment agent comprising, as active ingredients,
5 4-oxo-4-[(2-phenylethyl)amino]-butyric acid and a compound of formula (1) of [1];

[4] A plant seed treated with effective amounts of 4-oxo-4-[(2-phenylethyl)amino]-butyric acid and a compound of formula (1) of [1];

10 [5] A method of promoting root growth of plants, which comprises applying effective amounts of 4-oxo-4-[(2-phenylethyl)amino]-butyric acid and a compound of formula (1) of [1] to a plant or growing site of plant;

[6] The method of promoting root growth of plants according
15 to [5], wherein the plant is seed or seedling;

[7] The method of promoting root growth of plants according to [5], wherein the growing site of plant is soil before or after planting the plant on it;

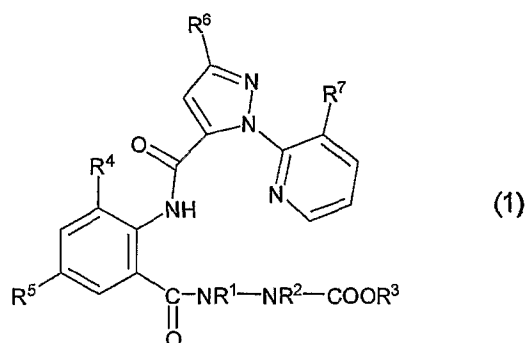
[8] The method of promoting root growth of plants according
20 to [5], wherein the growing site of plant is culture solution; and

[9] Combined use of 4-oxo-4-[(2-phenylethyl)amino]-butyric acid and a compound of formula (1) of [1] for promoting root growth of plants.

25 The composition of the present invention exerts plant root growth-promoting efficacy and pest controlling efficacy.

Mode for Carrying Out the Invention

The composition of the present invention comprises, as active ingredients, 4-oxo-4-[(2-phenylethyl)amino]-butyric acid (hereinafter, referred to as the compound I in some cases) and a compound of formula (1):



5 wherein, R^1 represents a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), R^2 represents a hydrogen atom or a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), R^3 represents a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), a C3-C6 alkoxyalkyl group optionally substituted with (a) halogen atom(s), a C3-C6 alkenyl group optionally substituted with (a) halogen atom(s) or a C3-C6 alkynyl group optionally substituted with (a) halogen atom(s), R^4 represents a halogen atom or a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), R^5 represents a hydrogen atom, a halogen atom, a cyano group or a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), R^6 represents a hydrogen atom, a halogen atom, a cyano group, a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), a C1-C6 alkoxy group optionally substituted with (a) halogen atom(s), a C1-C6 alkylthio group optionally substituted with (a) halogen atom(s), a C1-C6 alkylsulfinyl group optionally substituted with (a) halogen

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atom(s) or a C1-C6 alkylsulfonyl group optionally substituted with (a) halogen atom(s), and R⁷ represents a halogen atom or a C1-C6 alkyl group optionally substituted with (a) halogen atom(s) (hereinafter, referred to as the present compound in some cases).

The compound I, 4-oxo-4-[(2-phenylethyl)amino]-butyric acid, is a compound described in Japanese Patent No. 4,087,942 and can be produced, for example, by the method described in the publication.

The compound I, 4-oxo-4-[(2-phenylethyl)amino]-butyric acid, may be a salt with a base. Examples of the basic salt of 4-oxo-4-[(2-phenylethyl)amino]-butyric acid include the followings:

metal salts such as alkali metal salts and alkali earth metal salts (for example, salts of sodium, potassium or magnesium); salts with ammonia; and salts with organic amines such as morpholine, piperidine, pyrrolidine, mono lower alkylamine, di lower alkylamine, tri lower alkylamine, monohydroxy lower alkylamine, dihydroxy lower alkylamine and trihydroxy lower alkylamine.

The compound of formula (1) will be explained. Examples of members represented by R¹ to R⁷ in the formula (1) include the following members.

Examples of "halogen atom" include a fluorine atom, chlorine atom, bromine atom and iodine atom.

Examples of "C1-C6 alkyl group optionally substituted with (a) halogen atom(s)" include a methyl group,

trifluoromethyl group, trichloromethyl group, chloromethyl group, dichloromethyl group, fluoromethyl group, difluoromethyl group, ethyl group, pentafluoroethyl group, 2,2,2-trifluoroethyl group, 2,2,2-trichloroethyl group, propyl group, isopropyl group, heptafluoroisopropyl group, butyl group, isobutyl group, sec-butyl group, tert-butyl group, pentyl group and hexyl group.

Examples of "C3-C6 alkoxyalkyl group optionally substituted with (a) halogen atom(s)" include a 2-methoxyethyl group, 2-ethoxyethyl group and 2-isopropoxyethyl group.

Examples of "C3-C6 alkenyl group optionally substituted with (a) halogen atom(s)" include a 2-propenyl group, 3-chloro-2-propenyl group, 2-chloro-2-propenyl group, 3,3-dichloro-2-propenyl group, 2-butenyl group, 3-butenyl group, 2-methyl-2-propenyl group, 3-methyl-2-butenyl group, 2-pentenyl group and 2-hexenyl group.

Examples of "C3-C6 alkynyl group optionally substituted with (a) halogen atom(s)" include a 2-propynyl group, 3-chloro-2-propynyl group, 3-bromo-2-propynyl group, 2-butyne group and 3-butyne group.

Examples of "C1-C6 alkoxy group optionally substituted with (a) halogen atom(s)" include a methoxy group, ethoxy group, 2,2,2-trifluoroethoxy group, propoxy group, isopropoxy group, butoxy group, isobutyloxy group, sec-butoxy group and tert-butoxy group.

Examples of "C1-C6 alkylthio group optionally substituted with (a) halogen atom(s)" include a methylthio group, trifluoromethylthio group, ethylthio group, propylthio

group, isopropylthio group, butylthio group, isobutylthio group, sec-butylthio group, tert-butylthio group, pentylthio group and hexylthio group.

Examples of "C1-C6 alkylsulfinyl group optionally substituted with (a) halogen atom(s)" include a methylsulfinyl group, trifluoromethylsulfinyl group, ethylsulfinyl group, propylsulfinyl group, isopropylsulfinyl group, butylsulfinyl group, isobutylsulfinyl group, sec-butylsulfinyl group, tert-butylsulfinyl group, pentylsulfinyl group and hexylsulfinyl group.

Examples of "C1-C6 alkylsulfonyl group optionally substituted with (a) halogen atom(s)" include a methylsulfonyl group, trifluoromethylsulfonyl group, ethylsulfonyl group, propylsulfonyl group, isopropylsulfonyl group, butylsulfonyl group, isobutylsulfonyl group, sec-butylsulfonyl group, tert-butylsulfonyl group, pentylsulfonyl group and hexylsulfonyl group.

Examples of the present compound include the following compounds:

a compound of the formula (1) in which R^1 is a hydrogen atom, methyl group, ethyl group or isopropyl group, R^2 is a hydrogen atom, methyl group or ethyl group, R^3 is a methyl group or ethyl group, R^4 is a halogen atom or methyl group, R^5 is a halogen atom or cyano group, R^6 is a halogen atom or trifluoromethyl group and R^7 is a halogen atom;

a compound of the formula (1) in which R^1 is a hydrogen atom, R^2 is a hydrogen atom, R^3 is a methyl group, R^4 is a

chlorine atom, bromine atom or methyl group, R⁵ is a chlorine atom, bromine atom or cyano group, R⁶ is a chlorine atom, bromine atom or trifluoromethyl group and R⁷ is a chlorine atom;

5 a compound of the formula (1) in which R¹ is a methyl group, R² is a methyl group, R³ is a methyl group, R⁴ is a chlorine atom, bromine atom or methyl group, R⁵ is a chlorine atom, bromine atom or cyano group, R⁶ is a chlorine atom, bromine atom or trifluoromethyl group and R⁷ is a chlorine
10 atom;

a compound of the formula (1) in which R¹ is a methyl group, R² is a hydrogen atom, R³ is a methyl group, R⁴ is a chlorine atom, bromine atom or methyl group, R⁵ is a chlorine atom, bromine atom or cyano group, R⁶ is a chlorine atom,
15 bromine atom or trifluoromethyl group and R⁷ is a chlorine atom;

a compound of the formula (1) in which R¹ is an ethyl group, R² is a hydrogen atom, R³ is a methyl group, R⁴ is a chlorine atom, bromine atom or methyl group, R⁵ is a chlorine
20 atom, bromine atom or cyano group, R⁶ is a chlorine atom, bromine atom or trifluoromethyl group and R⁷ is a chlorine atom; and

a compound of the formula (1) in which R¹ is an ethyl group, R² is an ethyl group, R³ is a methyl group, R⁴ is a
25 chlorine atom, bromine atom or methyl group, R⁵ is a chlorine atom, bromine atom or cyano group, R⁶ is a chlorine atom, bromine atom or trifluoromethyl group and R⁷ is a chlorine atom.

Specific examples of the present compound include compounds 1 to 44 in which R^1 to R^7 of the formula (1) are one of the combinations of members shown in Tables 1 and 2.

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Table 1

Compound No.	R^1	R^2	R^3	R^4	R^5	R^6	R^7
1	CH ₃	CH ₃	CH ₃	Br	Br	Br	Cl
2	CH ₃ CH ₂	H	CH ₃	Br	Br	Br	Cl
3	CH ₃	H	CH ₃	CH ₃	Cl	Br	Cl
4	CH ₃	H	CH ₃	Br	Br	Br	Cl
5	(CH ₃) ₂ CH	H	CH ₃	Br	Br	Br	Cl
6	CH ₃	H	CH ₃	CH ₃	Cl	CF ₃	Cl
7	CH ₃	CH ₃	CH ₃	CH ₃	Cl	Br	Cl
8	CH ₃	H	CH ₃	CH ₃	CN	Br	Cl
9	CH ₃	CH ₃	CH ₃	CH ₃	CN	Br	Cl
10	CH ₃	H	CH ₃	Cl	Cl	Br	Cl
11	CH ₃	H	CH ₃ CH ₂	Cl	Cl	Br	Cl
12	CH ₃	CH ₃	CH ₃	Cl	Cl	Br	Cl
13	CH ₃	CH ₃	CH ₃	Br	Cl	Br	Cl
14	CH ₃	CH ₃	CH ₃	CH ₃	Cl	Cl	Cl
15	CH ₃	CH ₃	CH ₃	Cl	Cl	Cl	Cl
16	CH ₃	CH ₃	CH ₃	Br	Br	Cl	Cl
17	CH ₃ CH ₂	H	CH ₃	Cl	Cl	Br	Cl
18	CH ₃	CH ₃	CH ₃	Br	Br	CF ₃	Cl
19	CH ₃ (CH ₂) ₂	H	CH ₃	Br	Br	Br	Cl
20	CH ₃	CH ₃ CH ₂	CH ₃	Br	Br	Br	Cl
21	CH ₃ CH ₂	CH ₃	CH ₃	Br	Br	Br	Cl
22	CH ₃ CH ₂	CH ₃ CH ₂	CH ₃	Br	Br	Br	Cl
23	CH ₃ CH ₂	H	CH ₃	CH ₃	Cl	Br	Cl
24	CH ₃ CH ₂	H	CH ₃	CH ₃	CN	Br	Cl
25	CH ₃ CH ₂	H	CH ₃	Br	Br	Cl	Cl

Table 2

Compound No.	R ¹	R ²	R ³	R ⁴	R ⁵	R ⁶	R ⁷
26	CH ₃ CH ₂	H	CH ₃	Cl	Cl	Cl	Cl
27	CH ₃ CH ₂	H	CH ₃	CH ₃	Cl	Cl	Cl
28	CH ₃ CH ₂	H	CH ₃	CH ₃	CN	Cl	Cl
29	CH ₃ CH ₂	H	CH ₃	Br	Br	CF ₃	Cl
30	CH ₃ CH ₂	H	CH ₃	Cl	Cl	CF ₃	Cl
31	CH ₃ CH ₂	H	CH ₃	CH ₃	Cl	CF ₃	Cl
32	CH ₃ CH ₂	H	CH ₃	CH ₃	CN	CF ₃	Cl
33	CH ₃	H	CH ₃	Br	Br	CF ₃	Cl
34	CH ₃	H	CH ₃	Br	Br	Cl	Cl
35	H	H	CH ₃	Br	Br	Br	Cl
36	CH ₃	H	CH ₃	Cl	Cl	Cl	Cl
37	CH ₃	H	CH ₃	CH ₃	Cl	Cl	Cl
38	CH ₃	H	CH ₃	CH ₃	CN	Cl	Cl
39	CH ₃	H	CH ₃	Cl	Cl	CF ₃	Cl
40	CH ₃	H	CH ₃	CH ₃	CN	CF ₃	Cl
41	CH ₃	CH ₃	CH ₃	CH ₃	CN	Cl	Cl
42	CH ₃	CH ₃	CH ₃	Cl	Cl	CF ₃	Cl
43	CH ₃	CH ₃	CH ₃	CH ₃	Cl	CF ₃	Cl
44	CH ₃	CH ₃	CH ₃	CH ₃	CN	CF ₃	Cl

When the present compound has at least one acidic group, the compound may be a salt with a base. Examples of the salt thereof include metal salts such as alkali metal salts and alkali earth metal salts (for example, salts of sodium, potassium or magnesium); salts with ammonia; and salts with organic amines such as morpholine, piperidine, pyrrolidine, mono lower alkylamine, di lower alkylamine, tri lower alkylamine, monohydroxy lower alkylamine, dihydroxy lower alkylamine and trihydroxy lower alkylamine.

The present compound may have isomers such as tautomers and stereoisomers including optical isomers based on an asymmetric carbon atoms, and any isomer can be contained and used solely or in a mixture of any isomer ratio in the present invention.

The present compounds are compounds described in WO2007-043677 or WO2008-126933. These compounds can be produced, for example, by a method described in these publications.

While the composition of the present invention may be a simple mixture of the compound I and the present compound, it may be prepared by mixing the compound I, the present compound and an inert carrier, and adding to the mixture a surfactant or other adjuvants as needed so that the mixture can be used as such a formulation as emulsifiable concentrate, liquid agent, microemulsion, flowable agent, oil agent, wettable powder, granulated wettable powder, water soluble powder, dust formulation, granule, microgranule, seed-coating agent, seed-soaking agent, smoking agent, tablet, microcapsule, spray, aerosol, carbon dioxide gas preparaton, EW agent, trunk injection and trunk-coating agent. The composition of the present invention can be used as a root growth promoter, pesticide or seed treatment agent as it is or with the addition of other inert ingredients.

Examples of the solid carrier (dilution agent, extending agent) which can be used in the preparations include fine powders or granules such as plant powders (for example,

soybean flour, tobacco flour, wheat flour, wood flour and so on), mineral powders (for example, clays such as kaolin clay, Fubasami clay, bentonite and acid clay, talcs such as talc powder and agalmatolite powder, silicas such as diatomaceous earth and mica powder, and so on), synthetic hydrated silicon oxide, alumina, talc, ceramic, other inorganic minerals (sericite, quartz, sulfur, active carbon, calcium carbonate, hydrated silica and so on) and chemical fertilizers (ammonium sulfate, ammonium phosphate, ammonium nitrate, urea, ammonium chloride). One or more (preferably, one or more and three or less) of these solid carriers may be mixed at suitable proportion and used.

Examples of the liquid carrier include water, alcohols (for example, methyl alcohol, ethyl alcohol, n-propyl alcohol, isopropyl alcohol, butyl alcohol, hexyl alcohol, benzyl alcohol, ethylene glycol, propylene glycol, phenoxyethanol and so on), ketones (for example, acetone, methyl ethyl ketone, methyl isobutyl ketone, cyclohexanone and so on), ethers (for example, diisopropyl ether, 1,4-dioxane, tetrahydrofuran, ethylene glycol monomethyl ether, ethylene glycol dimethyl ether, diethylene glycol monomethyl ether, propylene glycol monomethyl ether, dipropylene glycol monomethyl ether, 3-methoxy-3-methyl-1-butanol and so on), aliphatic hydrocarbons (for example, hexane, cyclohexane, kerosene, lamp oil, fuel oil, machine oil and so on), aromatic hydrocarbons (for example, toluene, xylene, ethylbenzene, dodecylbenzene, phenylxylylethane, solvent naphtha, methylnaphthalene and so on), halogenated hydrocarbons (for example, dichloromethane,

trichloroethane, chloroform, carbon tetrachloride and so on), acid amides (for example, N,N-dimethylformamide, N,N-dimethylacetamide, N-methylpyrrolidone, N-octylpyrrolidone and so on), esters (for example, butyl lactate, ethyl acetate, 5 butyl acetate, isopropyl myristate, ethyl oleate, diisopropyl adipate, diisobutyl adipate, propylene glycol monomethyl ether acetate, fatty acid glycerin ester, γ -butyrolactone and so on), nitriles (for example, acetonitrile, isobutyronitrile, propionitrile and so on), carbonates (for example, propylene 10 carbonate and so on), and vegetable oils (for example, soybean oil, olive oil, linseed oil, coconut oil, palm oil, peanut oil, malt oil, almond oil, sesame oil, mineral oil, rosmarinic oil, geranium oil, rapeseed oil, cotton seed oil, corn oil, safflower oil, orange oil and so on). One or more 15 (preferably, one or more and three or less) of these liquid carriers may be mixed at suitable proportion and used.

Examples of the gaseous carrier include fluorocarbon, butane gas, LPG (liquefied petroleum gas), dimethyl ether and carbon dioxide gas. These gaseous carriers can be used singly 20 or two of them can be mixed in suitable proportion, or can be combined with a suitable liquid carrier, and used.

Examples of the surfactant include nonionic and anionic surfactants such as soaps, polyoxyethylene alkyl aryl ethers (for example, Noigen (product name, registered trademark, 25 manufactured by Dai-Ichi Kogyo Seiyaku Co., Ltd.), EA142 (EA142 (product name, manufactured by Dai-Ichi Kogyo Seiyaku Co., Ltd.)), Nonal (product name, manufactured by Toho Chemical Industry Co., Ltd.)), alkylsulfates (for example,

Emal 10 (product name, registered trademark, manufactured by Kao Corporation), Emal 40 (product name, registered trademark, manufactured by Kao Corporation)), alkylbenzene sulfonates (for example, Neogen (product name, registered trademark, manufactured by Dai-Ichi Kogyo Seiyaku Co., Ltd.), Neogen T (product name, registered trademark, manufactured by Dai-Ichi Kogyo Seiyaku Co., Ltd.), Neopelex (product name, registered trademark, manufactured by Kao Corporation), polyethylene glycol ethers (for example, Nonipole 85 (product name, registered trademark, manufactured by Sanyo Chemical Industries, Ltd.), Nonipole 100 (product name, registered trademark, manufactured by Sanyo Chemical Industries, Ltd.), Nonipole 160 (product name, registered trademark, manufactured by Sanyo Chemical Industries, Ltd.)), polyoxyethylene alkyl ethers (for example, Noigen ET-135 (product name, registered trademark, manufactured by Dai-Ichi Kogyo Seiyaku Co., Ltd.)), polyoxyethylene polyoxypropylene block polymers (for example, Newpole PE-64 (product name, registered trademark, manufactured by Sanyo Chemical Industries, Ltd.)), polyhydric alcohol esters (for example, Tween 20 (product name, registered trademark, manufactured by Kao Corporation), Tween 80 (product name, registered trademark, manufactured by Kao Corporation)), alkylsulfosuccinates (for example, Sanmorin OT20 (product name, registered trademark, manufactured by Sanyo Chemical Industries, Ltd.), Newcalgen EX70 (product name, manufactured by TAKEMOTO Oil & Fat Co., Ltd.)), alkyl naphthalene sulfonates (for example, Newcalgen WG-1 (product name, manufactured by TAKEMOTO Oil & Fat Co., Ltd.), and

alkenyl sulfonates (for example, Sorpole 5115 (product name, registered trademark, manufactured by Toho Chemical Industry Co., Ltd.)). One or more (preferably, one or more and three or less) of these surfactants can be mixed in suitable proportion and used.

Examples of the other additives include casein, gelatin, saccharides (starch, xanthan gum, gum arabic, cellulose derivatives, alginic acid and so on), lignin derivatives, bentonite, synthetic water-soluble polymers (polyvinyl alcohol, polyvinyl pyrrolidone, polyacrylic acids and so on), PAP (acidic isopropyl phosphate), BHT (2,6-di-tert-butyl-4-methylphenol), and BHA (mixture of 2-tert-butyl-4-methoxyphenol and 3-tert-butyl-4-methoxyphenol).

In the composition of the present invention, the weight ratio of the compound I to the present compound is typically in the range of 1:99 to 99:1, preferably 10:90 to 90:10. When the composition of the present invention is applied as a foliar spray, the weight ratio is typically in the range of 1:99 to 99:1, preferably 10:90 to 90:10. When used as a seed treatment agent, the weight ratio is typically in the range of 1:99 to 99:1, preferably 10:90 to 90:10. When used as a root growth promoter, the weight ratio is typically in the range of 1:99 to 99:1, preferably 10:90 to 90:10. When used as a pesticide, the weight ratio is typically in the range of 1:99 to 99:1, preferably 10:90 to 90:10.

In the composition of the present invention, the total

amount of the compound I and the present compound (hereinafter referred to as the amount of the active ingredients) is typically within a range from 0.01 to 95% by weight, preferably from 0.1 to 80% by weight, and more preferably from 1 to 60% by weight. When the composition of the present invention is prepared into emulsifiable concentrate, liquid agent, wettable powder, granulated wettable powder or water soluble powder, the amount of the active ingredients is typically within a range from 1 to 90% by weight, preferably from 1 to 80% by weight, and more preferably from 1 to 60% by weight. When the composition of the present invention is prepared into oil agent or dust formulation, the amount of the active ingredients is typically within a range from 0.01 to 90% by weight, preferably from 0.1 to 50% by weight, and more preferably from 0.1 to 20% by weight. When the composition of the present invention is prepared into granule, the amount of the active ingredients is typically within a range from 0.1 to 50% by weight, preferably from 0.5 to 50% by weight, and more preferably from 1 to 20% by weight.

In the composition of the present invention, the content of a liquid carrier or a solid carrier is, for example, within a range from 1 to 90% by weight, and preferably from 1 to 70% by weight, and the content of a surfactant is, for example, within a range from 1 to 20% by weight, and preferably from 1 to 15% by weight. When the composition of the present invention is prepared into liquid agent, the content of water is, for example, from 20 to 90% by weight and the content of the surfactant is from 1 to 20% by weight, and preferably from

1 to 10% by weight.

By applying effective amounts of the compound I and the present compound to plants or growing sites of plants, root growth of plants can be promoted and pests can be controlled. Examples of a plant which is the object of the application include foliages, seeds, bulbs and seedlings. As used herein, the bulb means a bulb, corm, rhizoma, stem tuber, root tuber and rhizophore. In the present specification, the seedling includes cutting and sugarcane stem cutting. Examples of the growing sites of plants include soil before or after planting plants, and a medium for water culture. Examples of the medium for water culture include water, culture solution, urethane and rock wool. As used herein, the culture solution is prepared by dissolving nutrient components required for plant growth in water so as to be adjusted to a proper concentration. The culture solution can also be used, for example, by soaking seeds or cuttings therein for their germination or rooting, or by soaking roots of plants therein or spraying it to roots to culture the plants.

Pests can be controlled by applying effective amounts of the compound I and the present compound to the pests or a place where the pests inhabit or a place where the pests may inhabit such as plant or soil.

When the application is conducted to a plant, growing site of plant or pests of plant, the compound I and the present compound may be separately applied for the same

period, but they are typically applied as the composition of the present invention for simplicity of the application.

Specific examples of the method of treatment with the composition of the present invention include treatment of foliage of plants, such as foliage application; treatment to cultivation lands of plants, such as soil treatment; treatment of the culture solution; treatment of seeds, such as seed soaking and seed coating; treatment of seedlings, such as application, soaking and coating; and treatment of bulbs such as seed tuber.

Specific examples of the treatment of foliage of plants in the present invention include treatment methods of applying to surfaces of plants, such as foliage spraying and trunk spraying. Examples of the treatment method of directly absorbing to plants before transplantation include a method of soaking entire plants or roots. A formulation obtained by using a solid carrier such as a mineral powder may be adhered to the roots.

Examples of the soil treatment method in the present invention include spraying onto the soil, soil incorporation, and perfusion of a chemical liquid into the soil (irrigation of chemical liquid, soil injection, and dripping of chemical liquid). Examples of the place to be treated include planting hole, furrow, around a planting hole, around a furrow, entire surface of cultivation lands, the parts between the soil and the plant, area between roots, area beneath the trunk, main furrow, growing soil, seedling raising box, seedling raising tray and seedbed. Examples of the treating period include

before seeding, at the time of seeding, immediately after seeding, raising period, before settled planting, at the time of settled planting, and growing period after settled planting. In the above soil treatment, active ingredients may be simultaneously applied to the plant, or a solid fertilizer such as a paste fertilizer containing active ingredients may be applied to the soil. Also active ingredients may be mixed in an irrigation liquid, and, examples thereof include injecting to irrigation facilities such as irrigation tube, irrigation pipe and sprinkler, and mixing into the flooding liquid between furrows. Alternatively, an irrigation liquid is mixed with active ingredients in advance and, for example, used for treatment by an appropriate irrigating method including the irrigating method mentioned above and the other methods such as sprinkling and flooding.

Examples of the treatment to the medium for water culture in the present invention include mixing into the culture solution.

Examples of the method of treating seeds or bulbs in the present invention include a method of treating seeds or bulbs with the composition of the present invention, and specific examples thereof include a spraying treatment in which a suspension of the composition of the present invention is atomized and sprayed over surfaces of seeds or bulbs, an smearing treatment in which a wettable powder, an emulsifiable concentrate or a flowable agent of the composition of the present invention is applied to seeds or bulbs with a small amount of water added or without dilution, an immersing

treatment in which seeds are immersed in a solution of the composition of the present invention for a certain period of time, a film coating treatment, and a pellet coating treatment.

5 Examples of the treatment of seedlings in the present invention include a spraying treatment in which a suspension of the composition of the present invention is atomized and sprayed over surfaces of seedlings, an smearing treatment in which a wettable powder, an emulsifiable concentrate or a
10 flowable agent of the composition of the present invention is applied to seedlings with a small amount of water added or without dilution, an immersing treatment in which seedlings are immersed in a solution of the composition of the present invention for a certain period of time.

15 When a plant or a growing site of plants is treated with the compound I and the present compound, the amounts of the compound I and the present compound used for the treatment may be changed depending on the kind of the plant to be treated,
20 formulation form, treatment period, climate condition and so on, but the amount of the active ingredients per 1,000 m² is typically within a range from 0.1 to 1,000 g, and preferably from 10 to 500 g.

 The emulsifiable concentrate, wettable powder, flowable
25 agent and microcapsule are typically diluted with water, and then sprinkled for the treatment. In these cases, the total concentration of the compound I and the present compound is typically within a range from 1 to 10,000 ppm, and preferably

from 10 to 500 ppm. The dust formulation and granule are typically used for the treatment without being diluted.

In the treatment of seeds, the amount of the active ingredients per one seed is typically within a range from 0.01 to 10 mg, and preferably 0.1 to 5 mg. The amount of the active ingredients per 100 kg of seeds is typically within a range from 1 to 300 g, and preferably from 5 to 100 g.

In the treatment of seedlings, the amount of the active ingredients per one seedling is typically within a range from 0.1 to 50 mg, and preferably from 1 to 20 mg. In the case of the treatment of cutting, the amount of the active ingredients per one cutting is typically within a range from 0.1 to 100 mg, and preferably from 1 to 50 mg. In the treatment of the soil before or after planting seedlings, the amount of the active ingredients per 1,000 m² is typically within a range from 0.1 to 400 g, and preferably from 1 to 200 g.

In the treatment of the culture solution, the total concentration of the active ingredients in the culture solution is within a range from 0.1 to 1000 ppm, and preferably from 1 to 100 ppm.

The composition of the present invention can protect plants from damages by the following pests (for example, harmful arthropods such as harmful insects and harmful mites) which cause damages such as feeding and sucking to plants. Examples of the pests against which the composition of the present invention has control efficacy include the followings.

Hemiptera: planthoppers such as small brown planthopper

(*Laodelphax striatellus*), brown rice planthopper (*Nilaparvata lugens*) and white-backed rice planthopper (*Sogatella furcifera*); leafhoppers such as green rice leafhopper (*Nephotettix cincticeps*) and green rice leafhopper (*Nephotettix virescens*); aphids such as cotton aphid (*Aphis gossypii*), green peach aphid (*Myzus persicae*), cabbage aphid (*Brevicoryne brassicae*), potato aphid (*Macrosiphum euphorbiae*), foxglove aphid (*Aulacorthum solani*), oat bird-cherry aphid (*Rhopalosiphum padi*) and tropical citrus aphid (*Toxoptera citricidus*); stink bugs such as green stink bug (*Nezara antennata*), bean bug (*Riptortus clavetus*), rice bug (*Leptocorisa chinensis*), white spotted spined bug (*Eysarcoris parvus*), brown marmorated stink bug (*Halyomorpha mista*) and tarnished plant bug (*Lygus lineolaris*); whiteflies such as greenhouse whitefly (*Trialeurodes vaporariorum*), sweetpotato whitefly (*Bemisia tabaci*) and silverleaf whitefly (*Bemisia argentifolii*); scales such as california red scale (*Aonidiella aurantii*), san jose scale (*Comstockaspis perniciosus*), citrus snow scale (*Unaspis citri*), red wax scale (*Ceroplastes rubens*) and cottony cushion scale (*Icerya purchasi*); lace bugs; psyllids;

Lepidoptera: pyralid moths such as rice stem borer (*Chilo suppressalis*), yellow stem borer (*Tryporyza incertulas*), rice leafroller (*Cnaphalocrocis medinalis*), cotton leafroller (*Notarcha derogata*), indian meal moth (*Plodia interpunctella*), oriental corn borer (*Ostrinia furnacalis*), european corn borer (*Ostrinia nubilalis*), cabbage webworm (*Hellula undalis*) and bluegrass webworm (*Pediasia*

teterrellus); owlet moths such as common cutworm (*Spodoptera litura*), beet armyworm (*Spodoptera exigua*), rice armyworm (*Pseudaletia separata*), cabbage armyworm (*Mamestra brassicae*), black cutworm (*Agrotis ipsilon*), beet semi-looper (*Plusia nigrisigna*), *Thoricoplusia* spp., *Heliothis* spp., and *Helicoverpa* spp.; Pieridae such as cabbage butterfly (*Pieris rapae*); tortricid moths such as *Adoxophyes* spp., oriental fruit moth (*Grapholita molesta*), soybean pod borer (*Leguminivora glycinivorella*), azuki bean podworm (*Matsumuraeses azukivora*), summer fruit tortrix (*Adoxophyes orana fasciata*), smaller tea tortrix (*Adoxophyes* sp.), oriental tea tortrix (*Homona magnanima*), apple tortrix (*Archips fuscocupreanus*), and codling moth (*Cydia pomonella*); leafblotch miners such as tea leafroller (*Caloptilia theivora*), and apple leafminer (*Phyllonorycter ringoneella*); fruitworm moths such as peach fruit moth (*Carposina niponensis*); lyonetiid moths such as *Lyonetia* spp.; tussock moths such as *Lymantria* spp., and *Euproctis* spp.; yponomeutid moths such as diamondback moths (*Plutella xylostella*); gelechiid moths such as pink bollworm (*Pectinophora gossypiella*), and potato tubeworm (*Phthorimaea operculella*); tiger moths such as fall webworm (*Hyphantria cunea*); tineid moths such as casemaking clothes moth (*Tinea translucens*), and webbing clothes moth (*Tineola bisselliella*);

25 Thysanoptera: thrips (*Thripidae*) such as yellow citrus thrip (*Frankliniella occidentalis*), melon thrip (*Thrips parvi*), yellow tea thrip (*Scirtothrips dorsalis*), onion thrip (*Thrips tabaci*), flower thrip (*Frankliniella intonsa*), tobacco

thrip (*Frankliniella fusca*);

Diptera: leaf miners such as oriental house fly (*Musca domestica*), common house mosquito (*Culex pipiens pallens*), common horse fly (*Tabanus trigonus*), onion maggot (*Hylemya antiqua*), seedcorn maggot (*Hylemya platura*), hyrcanus group mosquito (*Anopheles sinensis*), rice leafminer (*Agromyza oryzae*), rice leafminer (*Hydrellia griseola*), rice stem maggot (*Chlorops oryzae*) and legume leafminer (*Liriomyza trifolii*); melon fly (*Dacus cucurbitae*), Mediterranean fruit fly
10 (*Ceratitis capitata*);

Coleoptera: twenty-eight-spotted ladybird (*Epilachna vigintioctopunctata*), cucurbit leaf beetle (*Aulacophora femoralis*), striped flea beetle (*Phyllotreta striolata*), rice leaf beetle (*Oulema oryzae*), rice curculio (*Echinocnemus squameus*), rice water weevil (*Lissorhoptrus oryzophilus*), boll weevil (*Anthonomus grandis*), azuki bean weevil (*Callosobruchus chinensis*), hunting billbug (*Sphenophorus venatus*), Japanese beetle (*Popillia japonica*), cupreous chafer (*Anomala cuprea*), corn root worms (*Diabrotica* spp.), Colorado beetle
15 (*Leptinotarsa decemlineata*), click beetles (*Agriotes* spp.), cigarette beetle (*Lasioderma serricorne*), varied carper beetle (*Anthrenus verbasci*), red flour beetle (*Tribolium castaneum*), powder post beetle (*Lyctus brunneus*), white-spotted longicorn beetle (*Anoplophora malasiaca*), pine shoot beetle (*Tomicus*
20 *piniperda*);

Orthoptera: Asiatic locust (*Locusta migratoria*), African mole cricket (*Gryllotalpa africana*), rice grasshopper (*Oxya yezoensis*), rice grasshopper (*Oxya japonica*);

Hymenoptera: Cabbage sawfly (*Athalia rosae*), leaf-cutting ant (*Acromyrmex* spp.), fire ant (*Solenopsis* spp.);

Blattaria: German cockroach (*Blattella germanica*), smokybrown cockroach (*Periplaneta fuliginosa*), american
5 cockroach (*Periplaneta americana*), brown cockroach (*Periplaneta brunnea*) and oriental cockroach (*Blatta orientalis*);

Acarina: spider mites such as two-spotted spider mite (*Tetranychus urticae*), citrus red mite (*Panonychus citri*), and
10 *Oligonychus* spp.; eriophyid mites such as pink citrus rust mite (*Aculops pelekassi*); tarsonemid mites such as broad mite (*Polyphagotarsonemus latus*); false spider mites; peacock mites; flour mites such as mould mite (*Tyrophagus putrescentiae*); house dust mites such as American house dust
15 mite (*Dermatophagoides farinae*), European house dust mite (*Dermatophagoides pteronyssinus*); cheyletid mites such as *Cheyletus eruditus*, *Cheyletus malaccensis*, *Cheyletus moorei*;

Nematodes: rice white-tip nematode (*Aphelenchoides besseyi*), strawberry bud nematode (*Nothotylenchus acris*).

20

The composition of the present invention can be used in agricultural lands such as fields, paddy fields, lawns and orchards or in non-agricultural lands.

The present invention can be used in agricultural lands
25 for cultivating the following "plant" and so on to promote root growth of the plants and so on.

Examples of the crops are as follows:

crops: corn, rice, wheat, barley, rye, oat, sorghum,

cotton, soybean, peanut, buckwheat, beet, rapeseed, sunflower, sugarcane, tobacco, etc.;

vegetables: solanaceous vegetables (eggplant, tomato, pimento, pepper, potato, etc.), cucurbitaceous vegetables
5 (cucumber, pumpkin, zucchini, water melon, melon, squash, etc.), cruciferous vegetables (Japanese radish, white turnip, horseradish, kohlrabi, Chinese cabbage, cabbage, leaf mustard, broccoli, cauliflower, etc.), asteraceous vegetables (burdock, crown daisy, artichoke, lettuce, etc.), liliaceous vegetables
10 (green onion, onion, garlic, and asparagus), ammiaceous vegetables (carrot, parsley, celery, parsnip, etc.), chenopodiaceous vegetables (spinach, Swiss chard, etc.), lamiaceous vegetables (Perilla frutescens, mint, basil, etc.), strawberry, sweet potato, Dioscorea japonica, colocasia, etc.;

15 flowers;
foliage plants;
turf grasses;

fruits: pomaceous fruits (apple, pear, Japanese pear, Chinese quince, quince, etc.), stone fleshy fruits (peach,
20 plum, nectarine, Prunus mume, cherry fruit, apricot, prune, etc.), citrus fruits (Citrus unshiu, orange, lemon, lime, grapefruit, etc.), nuts (chestnuts, walnuts, hazelnuts, almond, pistachio, cashew nuts, macadamia nuts, etc.), berries
(blueberry, cranberry, blackberry, raspberry, etc.), grape,
25 kaki fruit, olive, Japanese plum, banana, coffee, date palm, coconuts, etc.; and

trees other than fruit trees; tea, mulberry, flowering plant, roadside trees (ash, birch, dogwood, Eucalyptus, Ginkgo

biloba, lilac, maple, Quercus, poplar, Judas tree, Liquidambar formosana, plane tree, zelkova, Japanese arborvitae, fir wood, hemlock, juniper, Pinus, Picea, and Taxus cuspidate), etc.

5 The aforementioned "plants" include plants, to which tolerance to HPPD inhibitors such as isoxaflutole, ALS inhibitors such as imazethapyr and thifensulfuron-methyl, EPSP synthetase inhibitors such as glyphosate, glutamine synthetase inhibitors such as glufosinate, acetyl-CoA carboxylase
10 inhibitors such as sethoxydim, and herbicides such as bromoxynil, dicamba and 2,4-D has been conferred by a classical breeding method or by genetic engineering techniques.

 Examples of a "plant" on which tolerance has been
15 conferred by a classical breeding method include rape, wheat, sunflower and rice tolerant to imidazolinone ALS inhibitory herbicides such as imazethapyr, which are already commercially available under a product name of Clearfield (registered trademark). Similarly, there is a soybean on which tolerance
20 to sulfonylurea ALS inhibitory herbicides such as thifensulfuron-methyl has been conferred by a classical breeding method, which is already commercially available under a product name of STS soybean.

 Examples of a plant on which tolerance to acetyl-CoA
25 carboxylase inhibitors such as trione oxime or aryloxy phenoxypropionic acid herbicides has been conferred by a classical breeding method include SR corn. The plant on which tolerance to acetyl-CoA carboxylase inhibitors has been

conferred is described in Proceedings of the National Academy of Sciences of the United States of America (Proc. Natl. Acad. Sci. USA), vol. 87, pp. 7175-7179 (1990). A variation of acetyl-CoA carboxylase tolerant to an acetyl-CoA carboxylase inhibitor is reported in Weed Science, vol. 53, pp. 728-746 (2005) and a plant tolerant to acetyl-CoA carboxylase inhibitors can be generated by introducing a gene of such an acetyl-CoA carboxylase variation into a plant by genetically engineering technology, or by introducing a variation conferring tolerance into a plant acetyl-CoA carboxylase.

Plants tolerant to acetyl-CoA carboxylase inhibitors or ALS inhibitors or the like can be generated by introducing into the plant cell a nucleic acid for introduction of base-substitution variation represented by Chimeraplasty Technique (Gura T. 1999. Repairing the Genome's Spelling Mistakes. Science 285: 316-318) to introduce a site-directed amino acid substitution variation into an acetyl-CoA carboxylase gene or an ALS gene of the plant.

Examples of a plant on which tolerance has been conferred by genetic engineering technology include corn, soybean, cotton, rape and sugar beet which are tolerant to glyphosate, and which have been commercially available under a product name of RoundupReady (registered trademark), AgrisureGT, and so on. There are corn, soybean, cotton and rape which are made tolerant to glufosinate by genetic engineering technology, which have been commercially available under a product name of LibertyLink (registered trademark). A cotton made tolerant to bromoxynil by genetic engineering

technology has been commercially available under a product name of BXN.

The aforementioned "plants" include crops genetically engineered to be able to synthesize selective toxins as known in genus *Bacillus*.

Examples of toxins expressed in such genetically engineered crops include: insecticidal proteins derived from *Bacillus cereus* or *Bacillus popilliae*; δ -endotoxins derived from *Bacillus thuringiensis* such as Cry1Ab, Cry1Ac, Cry1F, Cry1Fa2, Cry2Ab, Cry3A, Cry3Bb1 or Cry9C; insecticidal proteins such as VIP1, VIP2, VIP3 or VIP3A; insecticidal proteins derived from nematodes; toxins generated by animals, such as scorpion toxin, spider toxin, bee toxin, or insect-specific neurotoxins; mold fungi toxins; plant lectin; agglutinin; protease inhibitors such as a trypsin inhibitor, a serine protease inhibitor, patatin, cystatin, or a papain inhibitor; ribosome-inactivating proteins (RIP) such as lycine, corn-RIP, abrin, luffin, saporin, or briodin; steroid-metabolizing enzymes such as 3-hydroxysteroid oxidase, ecdysteroid-UDP-glucosyl transferase, or cholesterol oxidase; an ecdysone inhibitor; HMG-COA reductase; ion channel inhibitors such as a sodium channel inhibitor or calcium channel inhibitor; juvenile hormone esterase; a diuretic hormone receptor; stilbene synthase; bibenzyl synthase; chitinase; and glucanase.

Toxins expressed in such genetically engineered crops also include: hybrid toxins of δ -endotoxin proteins such as Cry1Ab, Cry1Ac, Cry1F, Cry1Fa2, Cry2Ab, Cry3A, Cry3Bb1, Cry9C,

Cry34Ab or Cry35Ab and insecticidal proteins such as VIP1, VIP2, VIP3 or VIP3A; partially deleted toxins; and modified toxins. Such hybrid toxins are produced from a new combination of the different domains of such proteins, by using a genetic engineering technique. As a partially deleted toxin, Cry1Ab comprising a deletion of a portion of an amino acid sequence has been known. A modified toxin is produced by substitution of one or multiple amino acids of natural toxins.

Examples of such toxins and genetically engineered plants capable of synthesizing such toxins are described in EP-A-0 374 753, WO 93/07278, WO 95/34656, EP-A-0 427 529, EP-A-451 878, WO 03/052073, and so on.

Toxins contained in such genetically engineered plants are able to confer resistance particularly to insect pests belonging to Coleoptera, Hemiptera, Diptera, Lepidoptera and Nematodes, to the plants.

Genetically engineered plants, which comprise one or multiple insecticidal pest-resistant genes and which express one or multiple toxins, have already been known, and some of such genetically engineered plants have already been on the market. Examples of such genetically engineered plants include YieldGard (registered trademark) (a corn variety for expressing Cry1Ab toxin), YieldGard Rootworm (registered trademark) (a corn variety for expressing Cry3Bb1 toxin), YieldGard Plus (registered trademark) (a corn variety for expressing Cry1Ab and Cry3Bb1 toxins), Herculex I (registered trademark) (a corn variety for expressing Cry1Fa2 toxin and phosphinotricine N-acetyl transferase (PAT) so as to confer

tolerance to glufosinate), NuCOTN33B (registered trademark) (a cotton variety for expressing Cry1Ac toxin), Bollgard I (registered trademark) (a cotton variety for expressing Cry1Ac toxin), Bollgard II (registered trademark) (a cotton variety for expressing Cry1Ac and Cry2Ab toxins), VIPCOT (registered trademark) (a cotton variety for expressing VIP toxin), NewLeaf (registered trademark) (a potato variety for expressing Cry3A toxin), NatureGard (registered trademark) Agrisure (registered trademark) GT Advantage (GA21 glyphosate-tolerant trait), Agrisure (registered trademark) CB Advantage (Bt11 corn borer (CB) trait), and Protecta (registered trademark).

The aforementioned "plants" also include crops produced by using a genetic engineering technique, which have ability to generate antipathogenic substances having selective action.

A PR protein and the like have been known as such antipathogenic substances (PRPs, EP-A-0 392 225). Such antipathogenic substances and genetically engineered crops that generate them are described in EP-A-0 392 225, WO 95/33818, EP-A-0 353 191, etc.

Examples of such antipathogenic substances expressed in genetically engineered crops include: ion channel inhibitors such as a sodium channel inhibitor or a calcium channel inhibitor, among which KP1, KP4 and KP6 toxins produced by viruses have been known; stilbene synthase; bibenzyl synthase; chitinase; glucanase; a PR protein; and antipathogenic substances generated by microorganisms, such as a peptide antibiotic, an antibiotic having a hetero ring and a protein

factor associated with resistance to plant diseases (which is called a plant disease-resistant gene and is described in WO 03/000906). These antipathogenic substances and genetically engineered plants producing such substances are described in
5 EP-A-0392225, WO95/33818, EP-A-0353191, and so on.

The "plant" mentioned above includes plants on which advantageous characters such as characters improved in oil stuff ingredients or characters having reinforced amino acid content have been conferred by genetically engineering
10 technology. Examples thereof include VISTIVE (registered trademark) low linolenic soybean having reduced linolenic content) or high-lysine (high-oil) corn (corn with increased lysine or oil content).

Stack varieties are also included in which a plurality
15 of advantageous characters such as the classic herbicide characters mentioned above or herbicide tolerance genes, harmful insect resistance genes, antipathogenic substance producing genes, characters improved in oil stuff ingredients or characters having reinforced amino acid content are
20 combined.

Examples

The present invention will be described in more detail by way of Formulation Examples, Seed Treatment Examples and
25 Test Example, but the present invention is not limited only to the following Examples. In the following Examples, the part represents part by weight unless otherwise specified.

Formulation Example 1

Five (5) parts of each of the compounds 1 to 44 shown in Tables 1 and 2 and 5 parts of the compound I are dissolved in a mixture of 35 parts of xylene and 35 parts of N,N-dimethylformamide, to which 14 parts of polyoxyethylene styryl phenyl ether and 6 parts of calcium dodecylbenzene sulfonate are added, and the mixture is well stirred to give respective emulsifiable concentrates.

10 Formulation Example 2

Ten (10) parts of each of the compounds 1 to 44 shown in Tables 1 and 2 and 10 parts of the compound I are added to a mixture of 4 parts of sodium lauryl sulfate, 2 parts of calcium lignin sulfonate, 20 parts of a synthetic hydrated silicon oxide fine powder and 54 parts of diatomaceous earth, and the mixture is stirred with a mixer to give respective wettable powders.

Formulation Example 3

20 To 1 part of each of the compounds 1 to 44 shown in Tables 1 and 2 and 1 part of the compound I, 1 part of a synthetic hydrated silicon oxide fine powder, 2 parts of calcium lignin sulfonate, 30 parts of bentonite and 65 parts of kaolin clay are added, followed by well mixing with stirring. Then, a suitable amount of water is added to the mixture, which is further stirred, granulated with a granulator and then air-dried to give respective granules.

Formulation Example 4

Dissolved are 0.5 parts of each of the compounds 1 to 44 shown in Tables 1 and 2 and 0.5 parts of the compound I in a proper amount of acetone, to which 5 parts of a synthetic hydrated silicon oxide fine powder, 0.3 parts of PAP and 93.7 parts of Fubasami clay are added, followed by well mixing with stirring. The removal of acetone by evaporation gives respective dust formulations.

10 Formulation Example 5

Five (5) parts of each of the compounds 1 to 44 shown in Tables 1 and 2, 5 parts of the compound I, 35 parts of white carbon containing 50 parts of a polyoxyethylene alkyl ether sulfate ammonium salt, and 55 parts of water are mixed and the mixture is finely ground by a wet grinding method to give respective flowable formulations.

Formulation Example 6

Dissolved are 0.05 parts of each of the compounds 1 to 44 shown in Tables 1 and 2 and 0.05 parts of the compound I in 5 parts of xylene and 5 parts of trichloroethane, followed by mixing with 89.9 parts of a deodorized kerosine to give respective oil agents.

25 Seed Treatment Example 1

To 12.5 parts of each of the compounds 1 to 44 shown in Tables 1 and 2 and 12.5 parts of the compound I, 65 parts of cyclohexanone, 5 parts of NINATE 401-A and 5 parts of BLAUNON

BR-450 are added, followed by well mixing with stirring to give respective emulsifiable concentrates.

Then, the emulsifiable concentrate is diluted with water by 1,000 times to prepare a dilution, and rice seeds are
5 soaked in the dilution for 24 hours until active ingredients are absorbed into the rice seeds to give treated seeds.

Seed Treatment Example 2

Well mixed are 12.5 parts of each of the compounds 1 to
10 44 shown in Tables 1 and 2, 12.5 parts of the compound I, 25 parts of clay for the formulation, 25 parts of polyvinyl alcohol containing 50 parts of SOLGEN TW-20, and 25 parts of water with stirring to give respective materials for forming pellets.

15 Then, cabbage seeds are embedded in the center of 20 mg of the material for forming pellets, followed by forming into spheres and further drying to give treated seeds.

Seed Treatment Example 3

20 Mixed are 12.5 parts of each of the compounds 1 to 44 shown in Tables 1 and 2, 12.5 parts of the compound I, 20 parts of white carbon containing 50% (weight) of a polyoxyethylene alkyl ether sulfate ammonium salt, and 55 parts of water, and finely ground by a wet grinding method to
25 give respective flowable formulations.

Cotton seeds are put in a stainless steel pot (having a volume of about 1,200 mL) equipped with a lifting blade for lifting seeds when the pot is rotated, and then the pot is

inclined at an angle of about 45 degrees and mechanically rotated so that satisfactory mixing and tumbling granulating effect can be obtained in the pot.

The flowable formulation is diluted with water by 100 times and a hand sprayer is turned toward the inside of the pot, and then the dilution is directly sprayed to the center of a tumbling granulating layer of cotton seeds. Furthermore, the sprayer is stopped and low-pressure air is sprayed to seeds, and then the seed coating is immediately dried.

Thereafter, spraying using a hand sprayer is restarted. This spraying and drying cycle is repeated until a predetermined amount of a fluid suspension is applied to seeds, to give treated seeds.

Test Example

One (1) part of each of the compound 2 and the compound I was dissolved in 99 parts of dimethyl sulfoxide and each of the resultant solutions was diluted with ion-exchange water so as to adjust the concentrations of the compound 2 and the compound I to 3 ppm and 10 ppm, respectively to thereby prepare respective test chemical solutions.

In the same manner, chemical solutions were prepared so as to adjust the concentrations of the compound 2 and the compound I to 6 ppm and 20 ppm, respectively, and then the respective chemical solutions were mixed in an equivalent amount to prepare a mixed test chemical solution containing 3 ppm of the compound 2 and 10 ppm of the compound I.

A cardboard in a seed growing bag (measuring 177 mm ×

163 mm, manufactured by Daiki Rika Kogyo Co., Ltd.) was impregnated with 17 ml of each of these test chemical solutions, and 3 seeds of *Raphanus sativus* were sown on the cardboard. The seed growing bag was placed in a plastic container, and the plastic container was sealed. After culturing in a bright place at 25°C for 7 days, the length of main root was measured. For comparison, the test was conducted in the same manner without treating with the test chemical solution, and the length of the main root was measured.

Each test was repeated three times and an average was calculated, and the main root length of each of chemical substance treated groups was calculated as a relative value, assuming the length of the main root of non-treated control group as 100.

As a result, the values obtained by using each compound were as shown in Table 3.

Table 3

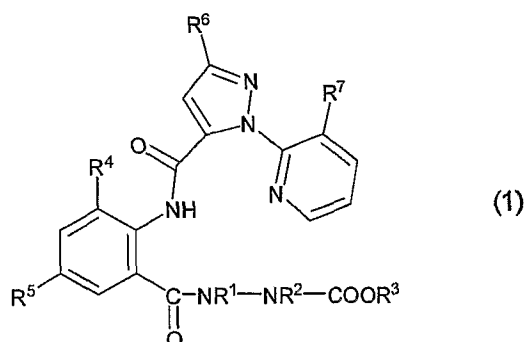
Compound	Relative value
Compound 2 + Compound I	184
Compound 2	148
Compound I	148
No treatment	100

Industrial Applicability

According to the present invention, a composition effective in promoting root growth of plants and controlling pests, and a method of promoting root growth of plants can be provided.

CLAIMS

1. A composition comprising, as active ingredients, 4-oxo-4-[(2-phenylethyl)amino]-butyric acid and a compound of formula (1):



wherein, R^1 represents a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), R^2 represents a hydrogen atom or a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), R^3 represents a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), a C3-C6 alkoxyalkyl group optionally substituted with (a) halogen atom(s), a C3-C6 alkenyl group optionally substituted with (a) halogen atom(s) or a C3-C6 alkynyl group optionally substituted with (a) halogen atom(s), R^4 represents a halogen atom or a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), R^5 represents a hydrogen atom, a halogen atom, a cyano group or a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), R^6 represents a hydrogen atom, a halogen atom, a cyano group, a C1-C6 alkyl group optionally substituted with (a) halogen atom(s), a C1-C6 alkoxy group optionally substituted with (a) halogen atom(s), a C1-C6 alkylthio group optionally substituted with (a) halogen atom(s), a C1-C6

alkylsulfinyl group optionally substituted with (a) halogen atom(s) or a C1-C6 alkylsulfonyl group optionally substituted with (a) halogen atom(s), and R⁷ represents a halogen atom or a C1-C6 alkyl group optionally substituted with (a) halogen atom(s).

2. A root growth promoter comprising, as active ingredients, 4-oxo-4-[(2-phenylethyl)amino]-butyric acid and a compound of formula (1) of claim 1.

3. A seed treatment agent comprising, as active ingredients, 4-oxo-4-[(2-phenylethyl)amino]-butyric acid and a compound of formula (1) of claim 1.

4. A plant seed treated with effective amounts of 4-oxo-4-[(2-phenylethyl)amino]-butyric acid and a compound of formula (1) of claim 1.

5. A method of promoting root growth of plants, which comprises applying effective amounts of 4-oxo-4-[(2-phenylethyl)amino]-butyric acid and a compound of formula (1) of claim 1 to a plant or growing site of plant.

6. The method of promoting root growth of plants according to claim 5, wherein the plant is seed or seedling.

7. The method of promoting root growth of plants according to claim 5, wherein the growing site of plant is

soil before or after planting the plant.

8. The method of promoting root growth of plants according to claim 5, wherein the growing site of plant is
5 culture solution.

9. Combined use of 4-oxo-4-[(2-phenylethyl)amino]-butyric acid and a compound of formula (1) of claim 1 for promoting root growth of plants.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/059058

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. A01N37/30 (2006.01) i, A01G7/06 (2006.01) i, A01N47/24 (2006.01) i,
A01P21/00 (2006.01) i

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)

Int.Cl. A01N37/30, A01G7/06, A01N47/24, A01P21/00

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2010
Registered utility model specifications of Japan 1996-2010
Published registered utility model applications of Japan 1994-2010

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

CA/REGISTRY (STN)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	US 2002/0065228 A1 (Russell J. LINDERMAN and Dov BOROVSKY) 2002.05.30, Claim50, 58 (No Family)	1 2-9
Y A	JP 2008-280339 A (SUMITOMO CHEMICAL COMPANY, LIMITED) 2008.11.20, Claim1, 10 & US 2010/0048640 A & EP 2143721 A & WO 2008/126889 A1 & KR 10-2009-0129459 A & CN 101657439 A	1 2-9
A	Mihoko ITAGAKI et al., Plant and Soil, 2003, Vol.255, p.67-75	1-9
A	JP 2005-502716 A (E. I. DU PONT DE NEMOURS AND COMPANY) 2005.01.27, Claim1, TableE2 & US 2004/0209923 A1 & EP 1427285 A & WO 2003/024222 A1 & KR 10-2004-0035857 A & CN 1713819 A	1-9



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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“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

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“&” document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/059058

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 11-255607 A (SNOW BRAND SEED CO., LTD.) 1999.09.21, Claim1 & WO 1999/045774 A1	1-9
A	WO 2009/055044 A1 (VALENT BIOSCIENCES CORPORATION and VALENT U.S.A., CORPORATION) 2009.04.30, Claim1 (No Family)	1-9
A	JP 59-39803 A (NISSAN CHEMICAL INDUSTRIES, LTD.) 1984.03.05, Claim1 (No Family)	1-9