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(54) Title: A COMPOSITION FOR TREATING GANODERMA DISEASE IN PLANTS COMPRISING SILICIUM DIOXIDE

FIG. 1

(57) Abstract: A composition comprising organic fertilizer granule containing silicon dioxide (SiO_2) prepared using organic materials from oil palm mill wastes and silicon dioxide (SiO_2) powder. This composition is used for oil palm growth and controlling of Ganoderma disease in nursery, immature, and mature stages. This formulation may also be used for other plants affected by Ganoderma disease.

A COMPOSITION FOR TREATING GANODERMA DISEASE IN PLANTS COMPRISING SILICIUM DIOXIDE

FIELD OF THE INVENTION

The present invention relates to a composition for the treatment, inhibition and prevention of diseases caused by *Ganoderma boninense* in plants.

BACKGROUND OF THE INVENTION

Ganoderma disease affects many perennial crops like oil palm, coconut, tea, etc. The oil palm (*Elaeis guineensis Jacq.*) is an important economic crop that produces two types of oils: palm oil from the fibrous mesocarp and kernel oil from the seeds. Currently, the oil palm industry is under threat from a fungal disease called basal stem rot (BSR), which is caused by the fungus *Ganoderma boninense* and is the most serious disease affecting the oil palm; this is because the disease escapes the early disease detection. This fatal disease can lead to losses as much as 80% after repeated planting cycles. *Ganoderma* produces enzymes that degrade the oil palm tissue and affect the infected xylem, thus causing serious problems to the distribution of water and other nutrients to the top of the tree. *Ganoderma* infection is well defined by its lesion in the stem. It causes tree loss in palm stands and subsequent loss in yield of palm oil.

Most methods known in the art are time consuming and inefficient. Cultural methods of disease control are largely inefficient in minimising inoculum pressure and in reducing the disease incidence. Chemical methods in combination with soil amendments form short-term solutions for managing the disease and improving productivity. However, the disease escapes early detection and by the time fruiting bodies are detected, the disease is too advanced to response to any chemical treatments.

The other approach known in the art is employing biological control as part of disease management strategy or manipulating the gene expression of enzymes that inhibits the growth of the pathogenic organism and its effects.

The role of silicon in enhancing the resistance of various plants like rice, wheat, sugarcane, etc. to biotic and abiotic stress is well known in the art for instance:

1. Voleti, S.R., A.P. Padmakumari, V.S. Raju, S. M. Babu, and S. Ranganathan. 2008. Effect of silicon solubilizers on silica transportation, induced pest and disease resistance in rice (*Oryza sativa* L.). Crop Protection 27 (2008) 1398– 1402.
2. Caia, K, D. Gaoa, S. Luoa, R. Zenga, J. Yang, and X. Zhub. 2008. Physiological and cytological mechanisms of silicon-induced resistance in rice against blast disease. Physiologia Plantarum 134: 324–333.
3. Datnoff, L.E. and F.A. Rodrigues. 2005. The role of silicon in suppressing rice diseases. APSnet feature.
4. Kim, S. G., K.W. Kim, E.W. Park, and D. Choi. 2002. Silicon-induced cell wall fortification of rice leaves: A possible cellular mechanism of enhanced host resistance to blast. Phytopathology 92:1095-1103.

The defense of these plants enriched with silicon against the diseases are attributed to the increase in the thickness of the cell wall of any plant parts and the excretion of certain chemicals for defense against pathogens, such as amino acids and enzymes.

US Patent Publication US2010/0255124 discloses a composition comprising two or more compounds, wherein the first of said two or more compounds is selected from the group consisting of isobutyric acid, methyl isobutyrate and isobutyric anhydride; and wherein the second of said two or more compounds is selected from the group consisting of isobutyric acid, methyl isobutyrate, isobutyric anhydride, ethyl isobutyrate, propyl isobutyrate, isobutyric acid-allyl ester, naphthalene, caryophyllene, and a plant essential oil. Extraction, selection of appropriate compounds and percentage of each in the composition is cumbersome.

However, none of the known composition and methods relates to the use of organic fertilizer containing silicon for controlling Ganoderma disease of oil palm.

SUMMARY OF THE INVENTION

Accordingly, the invention relates to provide a composition for treating, inhibiting and preventing Ganoderma disease in plants in particular oil palm plants. The said composition comprises of an organic fertilizer and silicon dioxide (SiO_2) which allows control of plant pathogens causing Ganoderma disease, in particular Ganoderma disease caused by *Ganoderma boninenses* which affects oil palm plants.

In another embodiment of the invention, a process of making a composition for the treatment, inhibition and prevention of Ganoderma disease in plants includes the steps of (a) air drying an organic fertilizer at a temperature ranging from 25-30°C; (b) converting the air-dried organic fertilizer to powder form of a size of <2.0 mm by grinding and passing it through a sieve <2.0 mm sieve size; (c) mixing the said powdered organic fertilizer with silicon dioxide (SiO_2) powder in a granulator at a moisture level of 240% (w/w) during mixing to form granules of diameter < 5.0 mm; and (d) air drying the granules of step (c).

In yet another embodiment of the invention, a method of treating, inhibiting and preventing Ganoderma disease in plants is also disclosed wherein the said method includes applying on a host plant the said composition which includes an organic fertilizer and silicon dioxide (SiO_2).

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 relates to composition granules (< 5.0 mm) of an embodiment of the invention comprising of 26.0 %(w/w) of silicon dioxide (SiO_2).

FIG. 2 relates is a graphic diagram showing the optimum rate of a composition of an embodiment of the invention applied for each month (left) and every three months (right) based on chlorophyll contents measured by SPAD value at 14 and 16 weeks of application in oil palm seedlings under the nursery condition.

FIG. 3 relates to oil palm seedlings treated with a composition of an embodiment of the invention and artificially inoculated with

Ganoderma boninense with no symptoms of BSR disease (left); while seedlings untreated with the composition of the present invention and artificially inoculated with *Ganoderma boninense* showing foliar symptoms of BSR disease and dead seedlings due to Ganoderma infection (right) at 8-month after treatment.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, this specification will describe the present invention according to the preferred embodiments of the present invention. However, it is to be understood that limiting the description to the preferred embodiments of the invention is merely to facilitate discussion of the present invention and it is envisioned that those skilled in the art may devise various modifications and equivalents without departing from the scope of the appended claims.

In one embodiment of the invention, a composition is disclosed for treating, inhibiting and preventing Ganoderma disease in plants, comprising an organic fertilizer and silicon dioxide (SiO_2).

The processed organic fertilizer may be organic wastes including oil palm mill wastes like, empty fruit bunch, decanter cake, and bunch ash.

The amount of silicon dioxide in the composition can range from 21.0 to 32.0% (w/w), optimally at 26.0% (w/w).

The composition of the present invention is preferably granular with granule size < 5 mm.

In another embodiment a process of making a composition for the treatment, inhibition and prevention of Ganoderma disease in plants is disclosed. Firstly, an organic fertilizer is air dried at a temperature ranging from 25-30°C, this fertilizer is then converted to powder form of a size of <2.0 mm by grinding and passing it through a sieve <2.0 mm sieve size, the powdered organic fertilizer is mixed with silicon dioxide (SiO_2) powder in a granulator to form granules in the presence of moisture of 240% (w/w), which is achieved by a very fine mist of water

sprayed on to a mixture of organic material with silicon dioxide at a rate of 240% (w/w), in the granulator and rotating the granulator until the composition forms granules of diameter < 5.0 mm. The granules are then air dried.

The content of SiO_2 in the composition is maintained at 21.0% to 32.0% (w/w), and optimally at 26.0 % (w/w) of the composition.

In another preferred embodiment of the invention, it is disclosed a method of treating, inhibiting and preventing Ganoderma disease in plant by applying a composition comprising an organic fertilizer and silicon dioxide (SiO_2) on a host plant.

The methods of treatment of plants for treating, inhibiting and preventing Ganoderma disease is provided wherein the plants are treated with a composition at the rate of 5 to 8 g/plant/month or 12 to 20 g/plant/3 month which is effective for plant growth and controlling *Ganoderma* disease in plants.

In a more preferred aspect of the invention, oil palm seedlings are treated with a composition of the present invention at the rate of 5 to 8 g/palm/month or 12 to 20 g/palm/3 month which is effective for oil palm seedlings growth and controlling *Ganoderma* disease in oil palm.

The various embodiments of the invention will be described in further detail with reference to the examples. It will be apparent to one skilled in the art that these examples are for illustrative purpose only and are not construed to limit the scope of the present invention.

Example 1:

One set of oil palm seedlings (left in FIG. 3) with no symptoms of BSR disease are treated with a composition of the invention with 26% (w/w) of silicon dioxide for 8 months at the rate of 5 to 8 g/palm/month and subsequently artificially inoculated with *Ganoderma boninense*. Meanwhile, the other set of seedlings that are artificially inoculated with *G. boninense* (right in FIG. 3) are

not treated with the composition of the present invention with 26% (w/w) of silicon dioxide. Rubber wood block (RWB) sitting technique was used to inoculate seedling with *G. boninense* as described by Idris et al., (2006). FIG. 3 shows the result of the treatment wherein foliar symptoms of BSR disease and dead seedlings due to Ganoderma infection is seen in the set of untreated plants (Right in FIG.3) at 8-month after inoculated with *G. boninense* using RWB sitting technique. However, the treated plants (left in FIG.3) show healthy growth, devoid of any symptoms of the disease.

Example 2:

One set of Oil palm seedlings with no symptoms of BSR disease are treated with the composition of the present invention with 26% (w/w) of silicon dioxide for 8 months at the rate of 12 to 20 g/palm/3 month and subsequently artificially inoculated with *Ganoderma boninense*. Meanwhile,the other set of seedlings that are artificially inoculated with *G. boninense* are treated with the composition of the present invention with 26% (w/w) of silicon dioxide for 8 months at the rate of 5 to 8 g/palm/month. Rubber wood block (RWB) sitting technique was used to inoculate seedling with G. boninense as described by Idris et al. (2006).

FIG. 2 shows the optimum rate of composition of the present invention applied for each month (left) and every three months (right) based on chlorophyll contents measured by SPAD value at 14 and 16 weeks of application in oil palm seedlings under the nursery condition.

Example 3:

Oil palm seedlings were treated with various concentrations of the composition of the present invention with 26% (w/w) of silicon dioxide after inoculation with *G. boninense* for 8 months and one set which was inoculated with *G. boninense* was left untreated (which served as control) to observe the disease severity as indicated by foliar symptoms. The observations are given in Tables 1 and 2.

Table 1: Disease severity as indicated by foliar symptoms of control and oil palm seedlings treated with the silicon dioxide containing composition during eight months after inoculation with Ganoderma.

Treatment (ppm)	Months							
	1	2	3	4	5	6	7	8
0	0.00 ± 0.00	1.25 ± 1.91	1.78 ± 2.18	3.48 ± 3.27	12.05 ± 6.13	24.43 ± 4.58	30.00 ± 3.82	50.40 ± 5.00
800	0.00 ± 0.00	0.00 ± 0.00	1.25 ± 1.91	1.67 ± 2.76	4.17 ± 4.17	7.92 ± 4.73	12.08±5. 42.00	19.28 ± 4.00
1200	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.83 ± 1.67	3.75 ± 2.24	7.97 ± 2.24	10.83±2. 76.00	17.08 ± 4.00
2000	0.00 ± 0.00	0.00 ± 0.00	0.83 ± 1.67	1.67 ± 2.04	4.17 ± 3.23	7.50 ± 2.50	12.50±3. 73.00	18.33 ± 3.00

The values are means of 10 replicates. (P≤0.05) with LSD t-test.

Table 2: Effect of the composition of the present invention containing 26% (w/w) of silicon dioxide and control treatments on number of primary roots infected and stems bulb tissues lesion of oil palm at 8 months after inoculation with Ganoderma. Values are means of 10 replicates.

Treatment	Internal symptoms	
ppm	No. of primary roots infected	Stem bulb tissues lesioned (cm^2)
Control	26.8 aA	13.6aA aA
800	18.0 dB	7.1 eB
1200	9.9 dC	5.5 eC
2000	11.4dC	6.8eC

Means in columns and followed by different letters are significantly different according to the LSD t test (P≤0.05). Small letters vertically refer to the comparison between treatments for the same source and capital letters horizontally refer to the comparison between sources of Si applied for the

treatment.

The rate of 26.0% (w/w) SiO_2 was selected based on the effectiveness of the composition for the prevention of Ganoderma disease in oil palm under nursery condition (FIG. 2). The effectiveness of in controlling Ganoderma disease was reported based on a quantitative assessment measured as a percentage severity of foliar symptoms (SFS conducted over eight months). At eight months after treatment, the percentage SFS of seedlings treated with fertilizer and pesticide composition of the present invention with 26% (w/w) of silicon dioxide showed significantly ($P<0.05$) lower severity of 17.08%±4.73 compared to the untreated seedlings with SFS of 50.40%±5.73 (Table 1). Meanwhile, the internal symptoms as indicated by number of internal root infected and stem bulb tissue lesioned showed significantly ($P<0.05$) lower values for the oil palm seedlings treated with fertilizer and pesticide composition of the present invention with 26% (w/w) of silicon dioxide compared to the control (Table 2).

Although the composition of this invention is directed in particular for treating, inhibiting and preventing Ganoderma disease in oil palm however, other plants may be applicable for example but not limited to dates, betel nuts, banana, coconut, rice, pine and many more other types of plants.

CLAIMS

1. A composition for treating, inhibiting and preventing Ganoderma disease in plants, comprising of an organic fertilizer and silicon dioxide (SiO_2).

2. The composition as claimed in claim 1 wherein the amount of silicon dioxide in the composition ranges from 21.0% to 32.0% (w/w).

3. The composition as claimed in claims 1 or 2 wherein the amount of silicon dioxide in the composition is 26% (w/w).

4. The composition as claimed in claim 1 wherein the said organic fertilizer is from organic wastes.

5. The composition as claimed in claim 1 or 4 wherein the organic wastes is preferably oil palm mill waste.

6. A process in producing a composition for the treatment, inhibition and prevention of Ganoderma disease in plants wherein the steps includes:
   a) air drying an organic fertilizer at a temperature ranging from 25 to 30 °C;
   b) converting the air-dried organic fertilizer to powder form of a size of <2.0 mm by grinding and passing it through a sieve <2.0 mm sieve size;
   c) mixing the said powdered organic fertilizer with silicon dioxide (SiO_2) in a granulator at a moisture level of 240% (w/w) during mixing to form granules of diameter < 5.0 mm; and
   d) air drying the granules of step (c).

7. The process as claimed in claim 6 wherein the amount of said silicon dioxide in the composition ranges from 21.0% to 32.0% (w/w).

8. The process as claimed in claims 6 or 7 wherein the amount of silicon dioxide in the composition is 26% (w/w).

9. The process as claimed in claim 6 wherein the said organic fertilizer is from organic wastes.

10. The process as claimed in claims 6 or 9 wherein the organic wastes is preferably oil palm mill waste.

11. A method of treating, inhibiting and preventing Ganoderma disease in plant, the said method comprises applying on a host plant a composition comprising an organic fertilizer and silicon dioxide (SiO_2).

12. The method as claimed in claim 11 wherein the said host plant is of plants from the group of palm trees.

13. The method as claimed in claims 11 or 12 wherein the host plant is oil palm.

14. The method as claimed in claim 11 wherein the amount of silicon dioxide ranges from 21.0% to 32.0% (w/w).

15. The method as claimed in claims 11 or 14 wherein the amount of silicon dioxide is 26% (w/w).

16. The method as claimed in claim 11 wherein the said organic fertilizer is from organic wastes.

17. The method as claimed in claims 11 or 16 wherein the organic wastes is preferably oil palm mill waste.

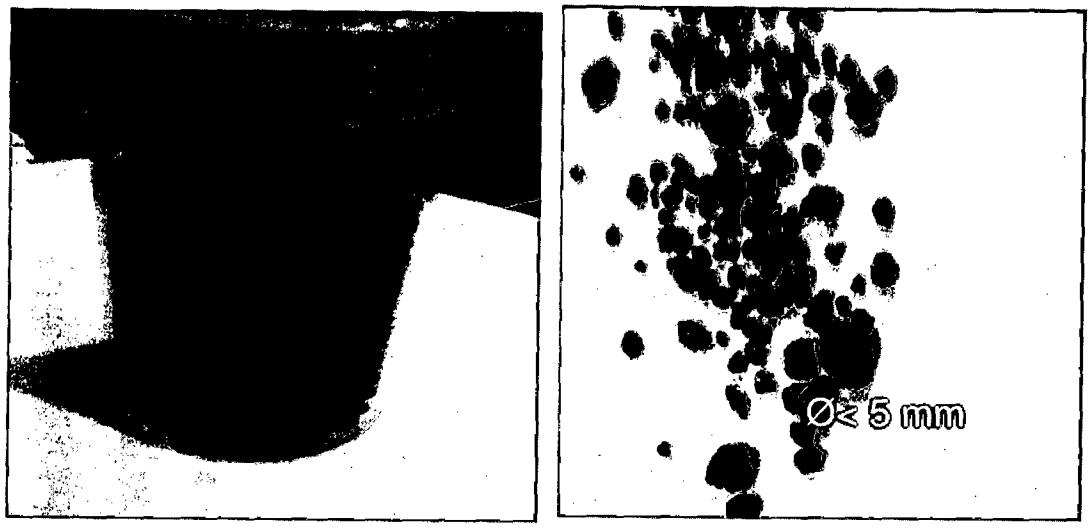

FIG. 1

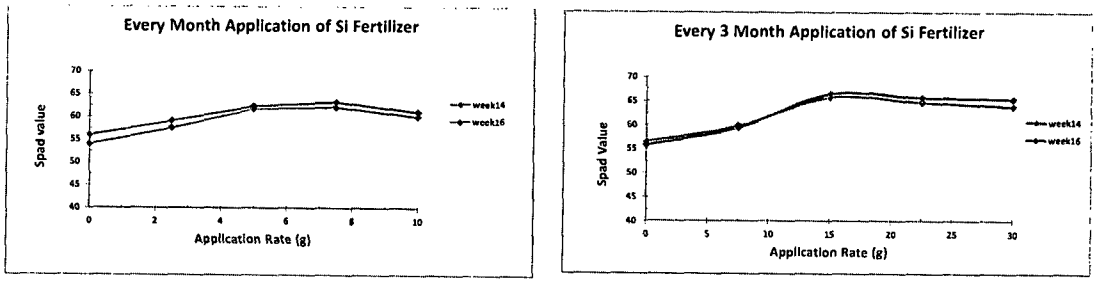

FIG. 2

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/MY2013/000203

A. CLASSIFICATION OF SUBJECT MATTER
INV. A01N59/00 A01N65/00
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

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, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DATABASE WPI Week 201325 Thomson Scientific, London, GB; AN 2012-P95997 XP002721835, & CN 102 616 951 A (LI M) 1 August 2012 (2012-08-01)	1-5
Y	the whole document	6-10

X	DATABASE WPI Week 201047 Thomson Scientific, London, GB; AN 2010-G97485 XP002721836, & CN 101 717 296 A (YAN H) 2 June 2010 (2010-06-02)	1-5
Y	the whole document	6-10

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

International application No
PCT/MY2013/000203

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DATABASE WPI Week 201040 Thomson Scientific, London, GB; AN 2010-F55509 XP002721837, & CN 101 704 691 A (CHINESE ACAD SCI INST GEOGRAPHICAL SCI&) 12 May 2010 (2010-05-12) the whole document -----	1-10
Y	Wong Mui ET AL: , 24 February 2011 (2011-02-24), XP55107881, Retrieved from the Internet: URL:http://sea.agrinos.com/sites/default/files/pdf/2011_02_24_Agrinos_Seminar_Kuala_Lumpur_Part_2_Overview_Research_Updates_of_Ganoderma_Incidence.pdf [retrieved on 2014-03-14] page 12 -----	11-17
Y	FAUTEUX F ET AL: "Silicon and plant disease resistance against pathogenic fungi", FEMS MICROBIOLOGY LETTERS, WILEY-BLACKWELL PUBLISHING LTD, GB, vol. 249, no. 1, 1 August 2005 (2005-08-01), pages 1-6, XP027871962, ISSN: 0378-1097 [retrieved on 2005-08-01] the whole document -----	11-17
Y	WO 2011/128262 A2 (BAYER CROPSCIENCE AG [DE]; EBBINGHAUS DIRK [DE]; HESSE KERSTIN [DE]; G) 20 October 2011 (2011-10-20) claims 6,7 pages 16-22 -----	11-17

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/MY2013/000203

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 102616951 A	01-08-2012	NONE	
CN 101717296 A	02-06-2010	NONE	
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WO 2011128262 A2	20-10-2011	EP 2377397 A1	19-10-2011
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		WO 2011128262 A2	20-10-2011