BIOCHEMICAL FERTILIZER COMPOSITION

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Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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Field of Search 504/117

References Cited

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ABSTRACT
Fertilizer compositions comprising:
A) an effective quantity of an inorganic or organic fertilizer; and
B) a quantity of beneficial microorganisms sufficient to further enhance plant growth when the fertilizer composition is applied to soil and/or control pathogens in the soil, and methods for their use.

20 Claims, No Drawings
BIOCHEMICAL FERTILIZER COMPOSITION

This application is a continuation-in-part of application Ser. No. 68,925,990, filed Sep. 9, 1997 now abandoned.

FIELD OF THE INVENTION

This invention relates to fertilizer compositions and methods for their use.

BACKGROUND OF THE INVENTION

The continuous use of chemical pesticides on plants, bushes and trees and especially those producing crops, has created an imbalance of the microbial eco-system in the soil which may be aim at. This results in the need for larger quantities of the chemical pesticides to maintain the same level of crop production, as well as an increased need for fertilizers.

One method used to try to overcome this problem is to use organic fertilizers, such as activated sludge, municipal compost, animal manures such as cow manure, and the like, that provide beneficial microbes to a plant. The use of these microbial organisms is the presence in them of toxic chemicals and/or toxic metals, that then accumulate in the soil.

DESCRIPTION OF THE INVENTION

Other than in the operating examples, or where otherwise indicated, all numbers expressing quantities of ingredients or reaction conditions are used herein are to be understood as modified in all instances by the term "about".

It has now been discovered that a fertilizer composition that overcomes all of the above drawbacks to the use of pesticides and conventional inorganic and organic fertilizers is a fertilizer comprising:

A) an inorganic fertilizer and/or an organic fertilizer which is free or substantially free from toxic chemicals and toxic metals, and

B) an effective quantity of beneficial microorganisms that a) enhance plant growth and, where applicable, crop production, and/or b) control various types of pathogens in the soil, optionally in combination with nutrients selected to maintain the viability of the microorganisms and their associated population. Such nutrients are well known to those skilled in microbiology.

The term "substantially free" used above means that the level of toxic chemicals and/or toxic metals in the organic fertilizer is so low that they are not detrimental to the soil or to plants growing in the soil to which the organic fertilizer is applied.

It is to be understood that the use of the term "plant" in the specification and in the claims is meant to include both crop producing and non-crop producing plants, bushes, and trees.

Component A) of the present composition can be a conventional balanced inorganic fertilizer e.g. having an N:P:K ratio of 6:10:4; 7:5: 5; 9:13:7; 18:6:12; 19:8:16; 20:33; 25:4:9; 28:4:9; 32:10:10, and the like. These numbers show the percentage of total nitrogen, available phosphorus pentoxide (P2O5) and soluble potash (K2O). This invention is of course not limited by the ratio of nitrogen to phosphorus to potassium in the inorganic fertilizer. The particular inorganic fertilizer selected will depend on the requirements of the soil to be fertilized.

Nitrogen can be present in the inorganic fertilizer in any convenient form, such as hydrous ammonia, aqueous ammonia, ammonium salts such as ammonium nitrate, calcium ammonium nitrate, ammonium phosphate, ammonium sulfate, and ammonium sulfate-nitrate, sodium nitrate, potassium nitrate, urea, cyanamide, and the like.

Phosphorus can be present in any convenient water-soluble form, such as CaHPO4, Ca2(H2PO4)2, single superphosphate (made by reacting ground phosphate rock with 70% sulfuric acid), ammonium phosphate, nitrates, phosphates, such as liquid ammonium polyphosphate, and the like.

Potassium can be present as commercial potash, potassium chloride, calcium (KCl, MgCl2, 6H2O), potassium sulfate, potassium nitrate, and the like.

Dry blended urea, diammonium phosphate, and potash is a common balanced inorganic fertilizer. While urea and possibly other nitrogen sources may be considered to be organic compounds, fertilizers containing them are predominantly inorganic and are commonly referred to as inorganic fertilizers.

The predominantly inorganic fertilizers used in the practice of the invention can optionally contain up to 30% by weight and preferably up to 50% by weight of organic nitrogen-containing compounds as all or part of the nitrogen source.

In addition to the primary nutrients, i.e., nitrogen, phosphorus and potassium, secondary nutrients can be present as needed, such as calcium, magnesium, and sulfur. Also, micronutrient elements can also be added if desired such as boron, manganese, zinc, copper, iron, and molybdenum.

While balanced inorganic fertilizers are most commonly used, inorganic fertilizers deficient in one or more of nitrogen, phosphorus and potassium can be used in the practice of the invention, as soil conditions may dictate, e.g., having an N:P:K ratio of 6:2:0; 0:10:0 (bone meal); 16:20:0 (ammonium phosphate); and the like.

Organic fertilizers that are free or substantially free from toxic chemicals and/or metals that can be used as component A), either alone or in combination with an inorganic fertilizer, include processed animal body and vegetable products such as blood meal, cottonseed meal, ocean kelp meal, fish fertilizers such as fish emulsion, feather meal, and the like. Such organic fertilizers do not normally contain component B) microorganisms, at least not in any meaningful quantity.

Component B) can be any beneficial microbial organism or combination of organisms known to enhance the quality of soil for the growth of plants. Such microorganisms include those from the genera Bacillus, Clostridium, such as Clostridium pasteurianum, Rhodospseudomonas, such as Rhodospseudomonas capsula, and Rhizobium that fix atmospheric nitrogen; phosphorous stabilizing Bacillus organisms such as Bacillus megaterium; cytokinin producing microorganisms such as Azotobacter vinelandii; and microorganisms from the genera Pseudomonas, such as Pseudomonas fluorescens, Atherbacter, such as Anthrobacter globii, Flavobacterium such as Flavobacterium sp., Saccharomyces, such as Saccharomyces cerevisiae, and the like.

Microorganisms useful in the practice of the invention can be selected from one or more of bacteria, fungi, and viruses that have utility in soil enhancement. Viruses such as the NPV virus (nuclear polyhedrosis virus) such as the cabbage looper nuclear polyhedrosis virus are examples of useful viruses.

Microorganisms, (bacteria, fungi and viruses) that control various types of pathogens in the soil include microorgan-
isms that control soil-borne fungal pathogens, such as Tri-
choderma sp., Bacillus subtilis, Penicillium sp.; microorgan-
isms that control insects, such as Bacillus sp. e.g. Bacillus
populi; microorganisms that act as herbicides, e.g. Alter-
naea sp., and the like.

All of the above microorganisms are well known and are
readily available from public depositories including ATCC
and NRRL.

Optimal components that can also be present in the
fertilizer compositions of the invention include natural
enzymes, growth hormones such as the gibberellins
(gibberellic acid and gibberellin plant growth hormones),
and control agents including Pesticides such as arsenicals
and mollusicides, insecticides, fungicides, nematocides,
and the like, depending on control on their compatibility with
the component B) microorganisms. Compounds useful as
control agents may have one activity only, but frequently are
effective in more than one of the above categories. Examples of
control agents that can be used in the compositions of the
invention, depending on component B) compatibility, may
include inorganic compounds such as elemental sulfur and
inorganic sulfur compounds, e.g. calcium polysulfide and
sodium thiosulfate, which are effective fungicides, copper,
zinc, and other metal in organisms such as copper carbonate
copper oxide, copper sulfate, and copper zinc sulfate.
Organosilicic compounds such as iron and tin compounds,
and organosilicic compounds such as iron and tin compounds,
e.g. tribenzyln tin hydroxide exhibit both insecticidal and
pesticidal activity. Saturated higher aliphyl alcohols, either
straight or branched chain, such as nonyl and decyl alcohol,
can be present as insecticides. Aldehydes such as meta-bi-
hydrly is an effective mollusicides, e.g. useful against snails.
Carboxylic acid derivatives, especially their mixed esters, are
potent arsenicals and fungicides, and when sulfur is also
present, e.g. mixed esters of thiophosphoric acids,
activity is further increased. 6-methylquinolino-2,3-
dithiocyclcarbonate is an effective acaricide, fungicide, and
insecticide. Carbamic acid derivatives such as nitrates of
N-methyl carbamic acid, e.g. 1-naphthyl-N-
methylcarbamate can also be used. Halogen substituted
aliphatic monobasic and dibasic carboxylic acids are effec-
tive pesticides. Natural pyrethrin and their synthetic ana-
logs are also effective pesticides. Salicylates are effective
against leaf mold and tomato brown spot. Heterocyclic com-
ounds possessing insecticidal and/or fungicidal activity can
also be used. Halogen derivatives of benzene, such as
paradichlorobenzene, are effective pesticides, often used
against the sugar beet weevil. Chitin-containing products are
effective miteicides. Other compounds that can be used
include aliphatic mercaptans having four or fewer carbon
atoms, organic sulfides and thioacetics, nitro compounds
such as chloropicrin dichloronitromethane, and chloromoni-
ropropene, copper and zinc inorganic and organic
compounds, e.g. copper hexaate, copper naphthenate, etc.,
organophosphorous compounds of which there are well over
a hundred, e.g. DDVP, teis-(2,4-diphenoxethyl) phosphite,
derivatives of mono- and dithiophosphoric acids, such as
0,0-diethyl S-[2-ethylthio]-ethyl phosphorodithioate, phos-
phoric acid derivatives, pyrophosphoric acid derivatives
and phosphonic acid derivatives, quinones, sulfonic acid
derivatives, thionocyanates and isocyanates, phthalimides,
insect killing soaps such as potassium fatty acid soaps, and
antialloteamins such as 7-methoxy-2,2-dimethylcromene
and the 6,7-dimethoxy analog. Distomaceous earth can be
used, which kills crawling insects.

These optional components can comprise from 0.001 to 0.1%
or more by weight of the fertilizer composition. Also,
alkalinizing agents such as ground limestone and acidifying
agents such as inorganic acids or acid salts can be added as
needed or desired.

The relative quantities of components A) and B) in the
compositions of the invention are dependent on the level of
activity of the microorganisms selected for component B). Preferably, component B) will consist of from 1x10^9 to
1,000 million microorganisms per gram of the fertilizer
composition, and more preferably from 1 million to 100
million microorganisms per gram of fertilizer composition,
with or without added nutrients for the microorganisms.

The fertilizer compositions of the invention can be in solid
form or in the form of an aqueous solution. Solid forms
include powders and larger particulate forms, e.g. from 20 to
200 mesh.

Where the fertilizer compositions are in solid form and
component B) microorganisms are sensitive to light, air, or
compounds in fertilizer component A) or to optional added
components, the microorganisms can be separately encapsu-
lated in water soluble coatings, e.g. dyed or undyed
gelatin spheres or capsules, or by micro-encapsulation to a
free flowing powder using one or more of galatin, polyvinyl
alcohol, ethylcellulose, cellulose acetate phthalate, or sty-
renes maleic anhydride. The separately encapsulated micro-
organisms can then be mixed with the powder or larger
particulates of component A) (which is not encapsulated)
and any optional components. Encapsulation of the micro-
organisms preferably includes nutrients as well as the micro-
organisms.

The presence of the component B) microorganisms in the
fertilizer compositions of the invention provides further
enhancement of plant growth, and where applicable, crop
production. i.e. by further enhancement is meant benefits in
plant growth and crop production in addition to the benefits
provided by the fertilizer component A), and/or provides
control of pathogens in the soil. The fertilizer compositions
of the invention can be added to soil to replenish chemical
elements that have been reduced or exhausted by the soils
from crops previously grown, or which have been leached
from the soils as a result of poor tillage practices, overirrigation,
or natural flooding, and to add nutrients to soils naturally deficient in them. The selection of the com-
ponent A) inorganic fertilizer can be customized to the
nutrient content of the soil to obtain particular growing
objectives.

The present invention also relates to a method for enhan-
cing the ability of soil to grow plants comprising the steps of:

I) analyzing the soil to determine (a) its nutritional require-
ments and (b) the presence of pathogens harmful to
plants to be grown in the soil;

II) formulating a fertilizer composition to satisfy the
nutritional requirements of the soil, to provide beneficial
microorganisms to further enhance plant growth, and
where needed to provide beneficial microorganisms
and/or chemical pest control agents to control patho-
genus found to be present; and,

III) applying the formulated fertilizer composition to the
soil.

The invention also relates to a method for formulating a
fertilizer composition comprising the steps of:

I) analyzing the soil to determine (a) its nutritional require-
ments, and (b) the presence of pathogens harmful
to plants to be grown in the soil; and,

II) formulating a fertilizer composition to satisfy the
nutritional requirements of the soil, to provide beneficial
microorganisms to further enhance plant growth, and
where needed to provide beneficial microorganisms
and/or chemical pest control agents to control patho-
genous found to be present.

In the above method, the fertilizer composition formu-
lated in step II can be, and preferably is, a fertilizer com-
position of the invention described above.
The invention will be illustrated but not limited by the
following examples.

EXAMPLES

Example 1
A fertilizer composition containing urea, ammonium
phosphate, and potassium chloride in a ratio of N:P:K of
25:6:4 with a particle size of 100 mesh is intimately mixed
with 1 million-500 million *Clostridium pasteurianum*, per
gram of the composition and 1 million-500 million
*Rhodopseudomonas capsulata* per gram of the composition
to form the finished fertilizer composition.

Example 2
A fertilizer composition containing ammonium sulfate,
triple superphosphate, and carnallite in a ratio of 3:2:1:10
with a particle size of 50 mesh is intimately mixed with 1
million-100 million *Bacillus megaterium* or *Bacillus subtilis*
in the form of gelatin microcapsules of about 1000
micron diameter, per gram of the composition, to form the
finished fertilizer composition.

Example 3
A liquid fertilizer composition is formulated containing
KNO₃, Ca₃(PO₄)₂, and KCl in a ratio of N:P:K of 18:6:12
in water in a concentration of 10% solids. To this aqueous
solution is added 1 million-100 million *Azotobacter globii*
per gram of solids.

What is claimed is:
1. A biochemical fertilizer composition comprising:
   
   A) a fertilizing effective quantity of a fertilizer for fertil-
esting soil which is either a) an essentially inorganic
   fertilizer, b) an organic fertilizer selected from the
   group consisting of blood meal, cottonseed meal, ocean
   kelp meal, and fish fertilizer, or c) a mixture of com-
   ponents a) and b); and
   
   B) a quantity of beneficial microorganisms in an amount of
   a least about 1 x 10⁶ microorganisms per gram of
   fertilizer sufficient to (a) further enhance plant growth
   when the fertilizer composition is applied to the soil;
   and/or (b) control one or more pathogens in the soil;
   wherein component B) but not component A) is optionally
   encapsulated in a water-soluble coating and wherein com-
   ponent A) a) can contain up to about 50% by weight of
   organic nitrogen-containing compounds.

2. The fertilizer composition of claim 1 wherein the 15
   quantity of component B) is also sufficient to further
   improve crop production in crop producing plants.

3. The fertilizer composition of claim 1 wherein compo-
   nent A) is present and is a balanced fertilizer containing
   fertilizing effective quantities of nitrogen, phosphorus, and
   potassium.

4. The fertilizer composition of claim 1 wherein compo-
   nent B) comprises from about 1 x 10⁶ to about 1,000 million
   microorganisms per gram of fertilizer composition.

5. The fertilizer composition of claim 1 wherein the 35
   composition also contains at least one additional plant
   nutrient.

6. The fertilizer composition of claim 1 wherein the
   composition also contains at least one of a gibberellin, an
   acaricide, an insecticide, a fungicide, a nematocide, and a
   molluscicide.

7. The fertilizer composition of claim 3 wherein nitrogen
   is in the form of at least one compound selected from the
   group consisting of ammonia, an ammonium salt, sodium or
   potassium nitrate, urea, and urea-formaldehyde reaction
   product.

8. The fertilizer composition of claim 3 wherein phos-
   phorus is in the form of at least one compound selected
   from the group consisting of Ca₃(PO₄)₂, Ca₃(H₂PO₄)₂, single
   superphosphate, triple superphosphate, ammonium
   phosphate, a nitrophosphate and a mononitrophosphate.

9. The fertilizer composition of claim 3 wherein potas-
   sium is in the form of at least one compound selected
   from the group consisting of potash, potassium chloride,
   carnallite, potassium sulfate, and potassium nitrate.

10. The fertilizer composition of claim 1 wherein com-
     ponent B) is at least one microorganism selected from the
     genera Bacillus, Clostridium, Rhodopseudomonas,
     Pseudomonas, Azotobacter, Phaeobacter, Saccharomyces,
     Azotobactor, Trichoderma, Pescillium, and Alternaria.

11. The fertilizer composition of claim 1 wherein the
    composition is in a powder or larger particulate form.

12. The fertilizer composition of claim 11 wherein com-
    ponent B) is in the form of particles encapsulated in a
    water-soluble coating.

13. The fertilizer composition of claim 12 wherein compo-
    nent B) is in the form of microcapsules.

14. The fertilizer composition of claim 12 wherein compo-
    nent B) also contains nutrients for the microorganisms.

15. A method of enhancing plant growth and/or crop
    production comprising applying to the soil in which plants
    are growing or are to be grown a growth enhancing quantity
    of the fertilizer composition of claim 1 wherein component
    A) thereof is formulated to fulfill the requirements of the
    plants and the soil to which the composition is applied, and
    component B) is formulated to enhance the growth of the
    plants and/or control one or more pathogens.

16. The composition of claim 1 wherein component A)
    can optionally contain up to about 35% by weight of organic
    nitrogen-containing compounds.

17. A method for formulating a fertilizer composition
    comprising the steps of:

    I) analyzing the soil to determine (a) its nutritional
        requirements and (b) the presence of pathogens harmful
        to plants to be grown in the soil; and

    II) formulating a fertilizer composition to satisfy the
        nutritional requirements of the soil, to provide benefi-
        cial microorganisms to further enhance plant growth,
        and where needed to provide beneficial microorgan-
        isms and/or chemical pest control agents to control
        pathogens found to be present by mixing together,
        either in dry form or in water, the predetermined
        quantities of the fertilizer components comprising the
        biochemical fertilizer composition of claim 1.

18. A method for enhancing the ability of soil to grow
    plants comprising the steps of:

    I) analyzing the soil to determine its nutritional
        requirements, and the presence of pathogens harmful to
        plants to be grown in the soil; and

    II) formulating a fertilizer composition in accordance with
        claim 1 to satisfy the nutritional requirements of the soil,
        to provide beneficial microorganisms to further
        enhance plant growth, and where needed to provide
        beneficial microorganisms and/or chemical pest control
        agents to control pathogens found to be present; and
III) applying the formulated fertilizer composition to the soil.

19. The method of claim 15 wherein the quantity of component B) is also sufficient to further improve crop production in crop producing plants.

20. The method of claim 18 wherein the quantity of component B) is also sufficient to further improve crop production in crop producing plants.