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(54) Title: FUNGICIDAL COMPOSITIONS FOR THE ENHANCEMENT OF TURF QUALITY

(57) Abstract

Fungicidal compositions for the protection of turfgrass against crown and root rot are disclosed. The compositions comprise, as the active material, (a) a monoester salt of a phosphorous acid (preferably aluminum ethyl phosphite), (b) an ethylene bisdithiocarbamate contact fungicide (preferably manganese-zinc ethylene bisdithiocarbamate), and (c) a benzoporphyrin compound. Preferred compositions comprise 1 part by weight of the monoester salt, 2 parts by weight of the ethylene bisdithiocarbamate, and between about 0.01 and about 0.1 parts by weight of the benzoporphyrin compound.

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FUNGICIDAL COMPOSITIONS FOR THE ENHANCEMENT OF TURF QUALITY

Field of the Invention

The present invention relates to methods and compositions for the enhancement of turf quality and the control of crown and root rot in turfgrass, and more particularly to synergistic combinations of fungicides useful therefore.

Background of the Invention

Crown and root rot is a serious disease of turfgrasses, especially highly maintained turfgrasses as found in lawns, golf courses, sod farms, and other landscape architecture applications. Current techniques for controlling this disease are not entirely satisfactory, and there is a continuing need for new treatments thereof.

U.S. Patent No. 4,698,334 to Horriere et al. and U.S. Patent No. 4,806,445 to Horriere et al. propose fungicidal compositions based on alkyl phosphites in combination with various contact fungicides such as Mancozeb. These compositions are useful for treating mildew in vines. U.S. Patent No. 4,139,616 to Ducret et al. describes fungicidal compositions based on alkyl phosphites. None of these references relate to the treatment of turfgrasses.

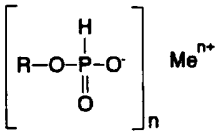
U.S. Patent No. 5,336,661 to Lucas discloses methods of enhancing turf quality of bentgrass using compositions comprising a mixture of a monoester salt of a phosphorous acid, and an ethylenebisdithiocarbamate contact fungicide.

High quality, healthy turfgrass is essential to the golfing industry. Accordingly, there remains a need in the art for fungicidal compositions which enhance turf quality and protect against crown and root rot in turfgrass to provide high quality, healthy turfgrass.

Summary of the Invention

As a first aspect, the present invention provides a fungicidal composition for enhancing the quality of turfgrass and protecting against crown and root rot. The compositions comprise a synergistic combination of:

(a) a monoester salt of a phosphorous acid of Formula (I):



(I)

wherein:

R is an alkyl radical having 2 to 4 carbon atoms,

Me is an alkali metal, alkaline earth metal, or aluminum atom, and

n is a whole number from 1 to 3 equal to the valence of Me;

(b) an ethylenebisdithiocarbamate contact fungicide selected from the group consisting of manganese ethylenebisdithiocarbamate and manganese-zinc ethylenebisdithiocarbamate; and

(c) a benzoporphyrin compound.

As a second aspect, the present invention provides a method of enhancing turf quality and protecting against crown and root rot. The method comprises applying

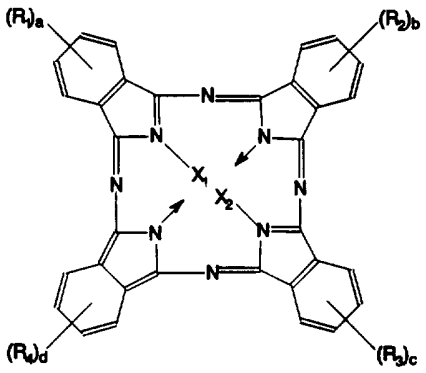
(a) a monoester salt of a phosphorous acid of Formula (I) above,

(b) an ethylenebisdithiocarbamate contact fungicide, and

(c) a benzoporphyrin compound.

The compounds are applied in an amount effective to enhance turf quality and/or protect against crown and root rot.

The benzoporphyrin compounds useful in the method of the present invention include substituted and unsubstitutedbenzoporphyrins and derivatives thereof. Suitable benzoporphyrins include tetrabenzoporphyrins alkyl-substituted methylbenzylporphyrins, halo-substituted benzoporphyrins, and the like. According to one embodiment, the benzoporphyrin is a coordination complex of the Formula L_1L_2-X_1X_2-L_3L_4, wherein X_1 and X_2 are each H or X_1 and X_2 together are a transition metal, and L_1, L_2, L_3, and L_4 are each independently substituted or unsubstituted isoindole groups, and wherein L_1, L_2, L_3, and L_4 are covalently joined to one another. In one preferred coordination complex, L_1, L_2, L_3, and L_4 together form a ligand of Formula (II)



(II)

wherein a, b, c, and d are each independently selected from positive integers 0-4, and R_1, R_2, R_3, and R_4 are each independently selected from the group consisting of H, halo, C_{1-20} substituted or unsubstituted, saturated or unsaturated, linear, branched or cyclic alkyl, alkoxy, alkylamino, alkylthio, onium, sulphonium, sulphate, and carboxylate.

The foregoing and other aspects of the present invention are explained in detail in the detailed description set forth below.

Detailed Description of the Invention

The methods and compositions described herein are useful for improving turf quality and color in turfgrasses. In addition, the methods and compositions described herein are useful for treating crown and root rot in turfgrass. Crown and root rot, which causes a decline in turfgrass quality during hot, wet weather, is a disease complex apparently caused by *Pythium* species and *Rhizoctonia* species in combination with environmental and management stresses.

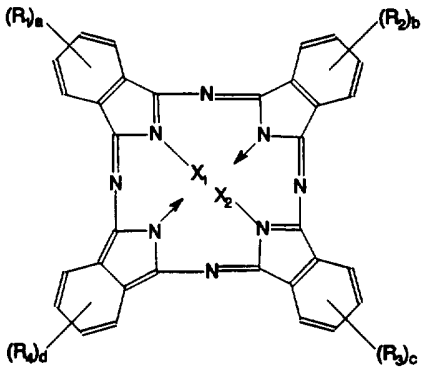
Monoester salts of phosphorus acids useful for carrying out the present invention, as given in Formula (I) above, are known. *See, e.g.*, U.S. Patent No. 4,139,616 to Ducret et al., U.S. Patent No. 4,698,334 to Horriere et al., and U.S. Patent No. 4,806,445 to Horriere et al. (the disclosures of all U.S. patents cited herein are to be incorporated herein by reference). Examples include calcium ethyl phosphite, sodium ethyl phosphite, aluminum ethyl phosphite, magnesium isopropyl phosphite, calcium isopropyl phosphite, aluminum isopropyl phosphite, magnesium ethyl phosphite, magnesium isobutyl phosphite, magnesium

sec-butyl phosphite, calcium isobutyl phosphite, aluminum N-butyl phosphite, aluminum *sec*-butyl phosphite, and aluminum isobutyl phosphite. Most preferred is aluminum ethyl phosphite (also called aluminum tris (O-ethyl phosphonate)).

Metallic ethylenebisdithiocarbamate contact fungicides, such as maneb (manganese ethylenebisdithiocarbamate) and mancozeb (manganese-zinc ethylene bisdithiocarbamate), are known. *See, e.g.*, U.S. Patent No. 4,698,334 to Horriere et al., and U.S. Patent No. 4,806,445 to Horriere et al. Mancozeb is currently preferred.

Benzoporphyrin compounds are the preferred class of porphine compounds and derivatives thereof, which are useful in the methods of the present invention. Examples of useful porphine compounds include substituted and unsubstituted porphines and derivatives thereof. Suitable derivatives of porphines include substituted and unsubstituted porphyrins. The porphyrins may be benzoporphyrins such as tetrabenzoporphyrins, alkyl-substituted benzylporphyrins, halo-substituted benzoporphyrins, and the like. According to one embodiment, the benzoporphyrin is a coordination complex of the Formula L_1L_2-X_1X_2-L_3L_4, wherein X_1 and X_2 are each H or X_1 and X_2 together are a transition metal, and L_1, L_2, L_3, and L_4 are each independently substituted or unsubstituted isoindole groups, and wherein L_1, L_2, L_3, and L_4 are covalently joined to one another (e.g., through a nitrogen or carbon atom, preferably a nitrogen atom). As will be apparent, they are covalently joined as a cyclic structure, i.e., -L_1-L_2-L_3-L_4-*cy*, where *cy* means L_4 is covalently joined to L_1. Preferably, X_1 and X_2 together are a transition metal from Groups IB and VIIIB. The isoindole groups represented by L_1, L_2, L_3, and L_4 may be unsubstituted, or alternatively, they may be each independently substituted from 1 to 4 times with a substituent selected from the group consisting of halogen, C_{1-20} substituted or unsubstituted, saturated or unsaturated, linear, branched or cyclic alkyl, alkoxy, alkylamino, alkylthio, onium, sulphonium, sulphate, and carboxylate.

In one preferred embodiment of the coordination complex of L_1L_2-X_1X_2-L_3L_4, L_1, L_2, L_3, and L_4 together form a ligand of Formula (II)



(II)

wherein a, b, c, and d are each independently selected from positive integers 0-4, and R_1, R_2, R_3, and R_4 are each independently selected from the group consisting of H, halogen, C_{1-20} substituted or unsubstituted, saturated or unsaturated, linear, branched or cyclic alkyl, alkoxy, alkylamino, alkylthio, onium, sulphonium, sulphate, and carboxylate.

Examples of suitable benzoporphyrins of the coordination complex L_1L_2-X_1X_2-L_3L_4 include phthalocyanine dyes. Suitable phthalocyanine dyes may be metal-free phthalocyanines, or metal phthalocyanines. The metal of metal phthalocyanines may be selected from alkali metals, alkali earth metals and transition metals, with transition metals being preferred. Examples of suitable metals include but are not limited to, lithium, sodium, potassium, rubidium and cesium from the alkali metal family; berillium, magnesium, calcium, strontium, barium, and radium from the alkali earth metal family; and copper, silver, gold, zinc, cadmium, mercury, scandium, yittrium, lanthanum, titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum, tungsten, manganese, technetium, rhenium, iron, ruthenium, osmium, cobalt, rhodium, iridium, nickel, palladium and platinum from the transition metal family. Copper, nickel, cobalt, iron, and zinc phthalocyanine dyes are particularly preferred in the methods of the present invention.

Phthalocyanine dyes which are useful in the methods of the present invention include subsituted and unsubstituted dyes. Suitable substituted phthalocyanine dyes may be metal-free phthalocyanines, or metal phthalocyanines, and may be substituted from 1 to 4 times on each isoindole group independently.

Examples of suitable substituents for the isoindole groups of phthalocyanine dyes include but are not limited to, halogens, substituted or unsubstituted, saturated or unsaturated, linear, branched or cyclic alkyl, alkoxy, alkylamino, alkylthio, onium, sulphonium, sulphate, and carboxylate. Suitable phthalocyanine dyes are commercially available and include but are not limited to Pigment Blue 16, Vat Blue 29, Pigment Blue 15, Heliogen Green GG, Ingrain Blue 14, Ingrain Blue 5, Ingrain Blue 1, Pigment Green 37, and Pigment Green 7. In one preferred embodiment, the phthalocyanine dye is Pigment Blue 15. In another preferred embodiment, the phthalocyanine dye is any phthalocyanine dye other than Pigment Blue 15.

Synergistic combinations of the foregoing three active ingredients (the three together being referred to herein as the "active material") are, in general, 1 part by weight of the compound of Formula (I) above in combination with from 1.5 to 2.5 parts by weight of the metallic ethylenebisdithiocarbamate and from 0.01 to 0.1, preferably 0.04 to 0.05 parts by weight of the benzoporphyrin compound. More preferably, the active material includes 1 part by weight of the compound of Formula (I) above in combination with from 1.75 to 2.25 parts by weight of the metallic ethylenebisdithiocarbamate and from 0.01 to 0.1 parts by weight of the benzoporphyrin compound. A particularly preferred combination is 1 part by weight of the compound of Formula (I) above in combination with 2 parts by weight of the metallic ethylenebisdithiocarbamate and from 0.04 to 0.05 parts by weight of Pigment Blue 15.

The synergistic combinations according to the invention may be used with advantage in admixture with one another or with other known fungicides, such as basic salts or hydroxides of copper (oxychloride, oxysulphate), (tetrahydro)phthalimides (Captan, Captafol, Folpel), methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate (Benomyl), thiophanates such as dimethyl (1,2-phenylene)bis(imino-carbonothioyl)bis(carbamate) (Thiophanate-methyl), tetrachloroisophthalonitrile (Chlorothalonil), 3-(3,5-dichlorophenyl)-N-(1-methylethyl)-2,4-dioxo-1-imidazolidine carboxamide (Iprodione), 1-[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl methyl]-1H-1,2,4-triazole (Propiconazole) 1-(4-chlorophenoxy)-3,3-dimethyl-1(1H-1,2,4-triazol-1-yl)-2-

butanone (Triadimafon) or other fungicides, either to complete the range of activity of the compounds according to the invention or to increase their persistence.

The synergistic combinations according to the invention may also be mixed with other fungicidal, anti-mildew phosphorus derivatives, especially 2-hydroxy-1,3,2-dioxaphospholanes, β-hydroxy ethyl phosphites and phosphorous acid and its salts.

For their practical application, the active ingredients in the synergistic combinations are used as part of a formulated product which, as a rule, contains a support and/or a surfactant in addition to the active material according to the invention.

In the context of the invention, a support is an organic or mineral, natural or synthetic material with which the active material is associated to facilitate its application to plants, seeds or soil, or its transportation and/or handling. The support can be solid (clays, natural or synthetic silicates, resins, waxes, solid fertilizers) or fluid (water, alcohols, ketones, petroleum fractions, chlorinated hydrocarbons, liquefied gases).

The surfactant can be an ionic or non-ionic emulsifier, dispersant or wetting agent such as, for example, salts of polyacrylic acids and lignin-sulphonic acids, condensates of ethylene oxide with fatty alcohols, fatty acids or fatty amines.

The compositions according to the invention can be prepared in the form of wettable powders, soluble powders, dusting powders, granulates, solutions, emulsifiable concentrates, emulsions, suspended concentrates and aerosols.

The wettable powders according to the invention can be prepared in such a way that they contain from 20 to 95% by weight of the active material, and they normally contain, in addition to a solid support, from 0 to 5% by weight of a wetting agent, from 3 to 10% by weight of a dispersant and, when necessary, from 0 to 10% by weight of one or more stabilizers and/or other additives, such as penetration agents, adhesives or anti-lumping agents, colorants, etc.

One example of the compositions of a wettable powder is given in **Table 1** below:

Table 1

Compound	% by wt.
active material	80
calcium lignosulphate (deflocculant)	5
anionic wetting agent	1
antilumping silica	5
kaolin (filler)	9

Powders soluble in water are obtained by mixing from 20 to 95% by weight of the active material, from 0 to 10% of an antilumping agent, the remainder being a hydrosoluble filler mainly a salt.

An example of a composition of the present invention as a soluble powder is given in **Table 2** below:

Table 2

Compound	% by wt.
active material	70
anionic wetting agent	0.5
antilumping silica	5
sodium sulfate (soluble filler)	24.5

Aqueous dispersions and emulsions, for example compositions obtained by diluting with water a wettable powder or an emulsifiable concentrate according to the invention, are included within the general scope of the invention. These emulsions can be of the water-in-oil type or of the oil-in-water type, and can have a thick consistency resembling that of a "mayonnaise".

The compositions according to the invention can contain other ingredients, for example protective colloids, adhesives or thickeners, thixotropic

agents, stabilizers or sequestrants, as well as other active materials known to have pesticidal properties, especially acaricides or insecticides.

The present invention can be practiced with all turfgrasses, including cool season turfgrasses and warm season turfgrasses. Examples of cool season turfgrasses are Bluegrasses (*Poa* L.), such as Kentucky Bluegrass (*Poa pratensis* L.), Rough Bluegrass (*Poa trivialis* L.), Canada Bluegrass (*Poa compressa* L.), Annual Bluegrass (*Poa annua* L.), Upland Bluegrass (*Poa glaucantha* Gaudin), Wood Bluegrass (*Poa nemoralis* L.), and Bulbous Bluegrass (*Poa bulbosa* L.); the Bentgrasses and Redtop (*Agrostis* L.), such as Creeping Bentgrass (*Agrostis palustris* Huds.), Colonial Bentgrass (*Agrostis tenius* Sibth.), Velvet Bentgrass (*Agrostis canina* L.), South German Mixed Bentgrass (*Agrostis* L.), and Redtop (*Agrostis alba* L.); the Fescues (*Festuca* L.), such as Red Fescue (*Festuca rubra* L.), Chewings Fescue (*Festuca rubra* var. *commutata* Gaud.), Sheep Fescue (*Festuca ovina* L.), Hard Fescue (*Festuca ovina* var. *duriuscula* L. Koch), Hair Fescue (*Festuca capillata* Lam.), Tall Fescue (*Festuca arundinacea* Schreb.), Meadow Fescue (*Festuca elatior* L.); the Ryegrasses (*Lolium* L.), such as Perennial Ryegrass (*Lolium perenne* L.), Italian Ryegrass (*Lolium multiflorum* Lam.); the Wheatgrasses (*Agropyron* Gaertn.), such as Fairway Wheatgrass (*Agropyron cristatum* (L.) Gaertn.), Western Wheatgrass (*Agropyron smithii* Rydb.). Other cool season turfgrasses include Beachgrass (*Ammophila* Host.), Smooth Brome (*Bromus inermis* Leyss.), Timothy (*Phleum* L.), Orchardgrass (*Dactylis glomerata* L.), Crested Dog's-Tail (*Cynosurus cristatus* L.). Examples of warm season turfgrasses are the Bermudagrasses (*Cynodon* L. C. Rich), Zoysiagrasses (*Zoysia* Willd.), St. Augustinegrass (*Stenotaphrum secundatum* (Walt.) Kuntze), Centipedegrass (*Eremochioa ophiuroides* (Munro.) Hack.), Carpetgrass (*Axonopus* Beauv.), Bahiagrass (*Paspalum notatum* Flugge.), Kikuyugrass (*Pennisetum clandestinum* Hochst. ex Chiov.), Buffalograss (*Buchloe dactyloides* (Nutt.) Engelm.), Blue Grama (*Bouteloua gracilis* (H.B.K.) Lag. ex Steud.), and Sideoats Grama (*Bouteloua curtipendula* (Michx. Torr.). Cool season turfgrasses are preferred. More preferred is Bluegrass, Bentgrass and Redtop, Fescue, and Ryegrass. Bentgrass is most preferred.

The active materials are, in general, applied to turfgrass either together or separately by spraying a liquid formulation (e.g., an aqueous formulation, including emulsions, or an oil-based formulation) thereof on the turfgrass. The ethylenebisdithiocarbamate contact fungicide is typically applied in an amount of from 10 to 25 pounds per acre (about 10 to 25 Kilograms per Hectare), more preferably in an amount of from 15 to 20 pounds per acre (about 15 to 20 Kg per hectare), and still more preferably in an amount of from 17 to 18 pounds per acre (about 17 to 18 Kg per Hectare). The compound of Formula (I) is, in general, applied in an amount of from 2/5 to 2/3, or more preferably 1/2, times the amount of the ethylenebisdithiocarbamate contact fungicide (e.g., from about 5 to 17 pounds per acre).

The following examples are provided to illustrate the present invention, and should not be construed as limiting thereof.

EXAMPLES 1-3

These examples were carried out to identify fungicide and combinations thereof which will improve turf quality and color, and have activity against crown and root rot and brown patch. Fungicides were evaluated on a one-year-old stand of the bentgrass cultivar "Penncross" planted in Raleigh, North Carolina, USA. The bentgrass was planted in native soil and maintained under conditions similar to a golf green with a mowing height of 0.635 cm (.25 inches). The fungicides which have activity against *Pythium* species include KOBAN™ (active ingredient: etridiazole) obtained from Grace-Sierra, ALIETTE™ (active ingredient: fosetyl-Al) obtained from Rhone-Poulenc, and SUBDUE™ (active ingredient: metalaxyl) obtained from Ceba-Giegy. The fungicides which have activity against *Pythium* and *Rhizoctonia* species is FORE™ (active ingredient: mancozeb, also including Pigment Blue 15) obtained from Rhom and Haas, MANZATE™ (active ingredient: mancozeb) obtained from DuPont, LESCO MN80™ (active ingredient: mancozeb) obtained from Lesco, PENCOZEB DF 75™ (active ingredient: mancozeb) obtained from Elf Atochem, PROTECT DG 80™ (active ingredient: mancozeb) obtained from W.A. Cleary, and DITHANE™ (active ingredient: mancozeb) obtained from Rhom and Haas.

The fungicides were applied separately and in combination at labelled rates to 1.5 m x 1.5 m (5 ft x 5 ft) plots of bentgrass prior to evidence of any decline in turf quality due to crown and root rot. A CO_2 backpack sprayer was used to apply the fungicide treatments at (30 lbs psi) using TEEJET™ 8004 nozzles to apply 9.5 liters (2.5 gallons) of fungicide dilutions per 93 square meters (1000 sq ft). The fungicides were initially applied and subsequently reapplied according to a 14 day schedule. In some experiments, an electrical pump sprayer was used to apply the treatments at 30 psi using a Teejet 8004 nozzle.

Turf quality, color and percent disease ratings were recorded weekly, based on a scale from 1-9, with 9 being ideal turf quality and color and 1 being all turf dead. The percent disease ratings were calculated based on the percent of area in each plot showing symptoms of brown patch. Turf quality and color ratings were used as an indicator of the health of the bentgrass and the amount of decline associated with crown and root rot. *Pythium* and *Rhizoctonia* species of fungi were isolated from the bentgrass in the experiment during the test period.

Table 1 below indicates that an improvement in turf quality and color from application of ALIETTE™ + FORE™ (treatment #4), observed with a turf quality of 7.5 and a turf color of 7.8 with 9 being ideal. The combination of ALIETTE™ + MANZATE™ had a lower turf quality rating of 6.8 and a turf color of 7.0.

TABLE 1

ALIETTE™/FORE™ Interaction

Trt. No.	Pesticide Name	Formu.	LBai/A	Turf Quality	Turf Color	% Brown Patch	Disease Control
01	CHECK	---	----	4.5	5.3	50.0	0
02	ALIETTE™ CHP26019	WDG 80 WDG 50	8.712 2.72	6.5	6.8	0	100.0
03	ALIETTE™ MANZATE	WDG 80 WP 70	8.712 16.34	6.8	7.0	0	100.0
04	ALIETTE™ FORE™	WDG 80 WP 80	8.712 17.42	7.5	7.8	0	100.0
05	ALIETTE™ PROSTAR	WDG 80 WP 50	8.712 5.445	5.8	5.5	0	100.0
06	ALIETTE™ DACONIL	WDG 80 WDG 90	8.712 14.7	6.3	6.8	0	100.0
07	FORE™	WDG 80	17.42	6.8	7.0	2.5	91.7
08	ALIETTE™	WDG 80	8.712	5.0	5.8	26.3	38.0
09	ALIETTE™ FORE™	WDG 80 WP 80	4.356 8.712	6.8	7.5	0	100.0
LSD (0.05) = STANDARD DEVIATION = COEFF. OF VARIABILITY =				1.0 .7 10.8	.8 .5 8.2	9.1 6.2 71.2	23.5 16.1 19.9

Table 2 below demonstrates the results of a comparative study of the effects of different formulations of mancozeb. ALIETTE™ and FORE™ was used as a control. The formulations of Daconil, CHP26019, and Banner gave good turf quality and turf color ratings.

TABLE 2

Trt. No.	Pesticide Name	Formu.	LBai/A	Application Type	Turf Quality	Turf Color	% Brown Patch	Turf Quality	Turf Color	% Brown Patch
01	CONTROL	Aliette	Fore		6.5	6.5	17.5	5.5	6.0	42.5
02	DACONIL	SG 82.5	8.98	14 Day	9.0	8.0	0	8.5	8.0	0
03	CHP 26019	WG 50	2.723	14 Day	8.5	7.5	0	7.0	7.0	0
04	KOBAN	WP 30	4.90	14 Day	6.5	6.5	15.0	5.5	5.5	55.0
05	SUBDUE	WP 25	1.36	14 Day	6.5	6.5	12.5	5.5	6.0	47.5
06	BAYLETON	WG 25	1.36	14 Day	7.0	7.5	3.8	6.5	6.5	17.5
07	BANNER	EC 1.1	1.50	14 Day	8.5	8.5	6.0	8.0	8.0	0
LSD (0.05) =					1.6	1.6	11.1	1.4	.8	21.0
STANDARD DEVIATION =					.6	.7	4.5	.6	.3	8.6
COEFF. OF VARIABILITY =					8.5	9.2	57.9	8.4	5.1	37.0

Table 3 below indicates that similar results were observed in a second test. The data demonstrate that ALIETTE™ + FORE™ (treatment #8) gave better turf quality of 7.8 and 8.0 than ALIETTE™ + mancozeb + AURAGREEN™ (another type of green dye) (treatment #5) of 7.0 and 7.3. The combination of the experimental formulation of ALIETTE™ and the blue pigment (EXP 10622) + mancozeb (treatment #10) gave higher turf quality ratings of 7.5 and 8.0 than treatment #5, and ratings as high as the ratings for ALIETTE™ + FORE™ on most dates.

TABLE 3

ALIETTE™/FORE™ Interaction

Trt. No.	Pesticide Name	Formu.	LBai/A	Application Type	Phyto rating	Turf Quality	% Brown Patch	Turf Quality	Turf Color	% Brown Patch
01	CONTROL	-----	-----	-----	1.0	5.0	25.0	5.3	6.3	15.0
02	NCAD 1	SG 100	0.545	14 DAY	1.0	4.8	21.3	5.0	7.5	16.3
03	NCAD 1 ALIETTE™	SG 100 WDG 80	0.545 8.712	14 DAY 14 DAY	1.8	5.8	15.0	6.3	7.5	5.0
04	NCAD 1 MANCOZEB	SG 100 WDG 80	0.545 17.43	14 DAY 14 DAY	1.3	6.3	7.5	6.8	7.8	0
05	NCAD 1 MANCOZEB ALIETTE™	SG 100 WDG 80 WDG 80	0.545 17.43 8.712	14 DAY 14 DAY 14 DAY	5.5	7.0	2.5	7.3	6.8	0
06	ALIETTE ™	WDG 80	8.712	14 DAY	2.5	5.3	16.3	6.0	6.3	2.5
07	MANCOZEB	WDG 80	17.43	14 DAY	2.0	6.0	13.8	6.5	6.8	8.8
08	ALIETTE™ FORE™	WDG 80 WP 80™	8.712 17.43	14 DAY 14 DAY	1.0	7.8	0	8.0	8.0	0
09	EXP10622	WDG 80	8.712	14 DAY	1.5	5.8	10.0	6.5	6.8	6.3
10	EXP10622 MANCOZEB	WDG 80 WP 80™	8.712 17.43	14 DAY 14 DAY	3.3	7.5	0	8.0	7.5	0
			LDS (0.05) =		.8	1.0	9.4	.6	1.0	6.8
			STANDARD DEVIATION =		.6	.7	6.5	.4	.7	4.7
			COEFF. OF VARIABILITY =		27.2	11.0	58.4	5.9	9.4	87.3

Table 4 is a comparative study of the effects of different formulations of mancozeb. The formulations of FORE™ WP80™ and FL4.0™, which contain mancozeb + Pigment Blue 15, gave better turf quality and turf color than other formulations of mancozeb without the Pigment Blue 15. Treatment #7 of ALIETTE™ + FORE™ FL4.0™+ BLENDEX™ (a blending agent) gave better results than treatment #2. Treatment #7 contains more Pigment Blue 15 than treatment #2.

TABLE 4

ALIETTE™/MANCOZEB Interactions

Trt. No.	Pesticide Name	Pesticide Formu.	Pesticide LBai/A	Appli-cation Type	Turf Qual.	Turf Color	% Brown Patch	Turf Qual.	Turf Color	% Brown Patch	Turf Qual.	Turf Color	% Brown Patch	Turf Qual.	Turf Color
01	CONTROL	-----	-----	-----	3.8	4.5	60.0	3.3	4.0	67.5	2.8	3.8	75.0	4.8	6.3
02	ALIETTE™ FORE™	WDG 80 WP 80™	8.712 17.42	14 DAY 14 DAY	7.0	7.0	10.0	7.8	7.5	5.0	7.3	7.0	5.0	7.0	6.8
03	ALIETTE™ LESCO MN	WDG 80 DG 80	8.712 17.42	14 DAY 14 DAY	6.0	6.3	12.5	6.0	6.0	1.3	6.0	6.0	8.8	5.8	5.3
04	ALIETTE™ PENCOZEB	WDG 80 DF 75	8.712 17.42	14 DAY 14 DAY	6.3	6.5	13.8	6.0	6.0	2.5	6.0	6.3	12.5	6.0	5.5
05	ALIETTE™ PROTECT	WDG 80 DG 80	8.712 17.42	14 DAY 14 DAY	6.0	6.5	11.3	6.3	6.3	5.0	6.3	6.3	8.8	5.8	5.3
06	ALIETTE™ FORE™	WDG 80 FL 4.0™	8.712 17.42	14 DAY 14 DAY	6.8	7.0	6.3	6.8	6.8	7.5	7.3	7.8	3.8	7.5	7.5
07	ALIETTE™ FORE™ BLENDEX	WDG 80 FL 4.0™ %C	8.712 17.42	14 DAY 14 DAY 14 DAY	7.0	7.3	5.0	8.5	7.8	0	8.0	8.0	1.3	8.0	8.0
08	ALIETTE™ DITHANE	WDG 80 WDG 75	8.712 17.42	14 DAY 14 DAY	4.3	4.8	46.3	5.8	6.0	2.5	5.8	5.8	17.5	6.0	5.5
09	LESCO MN	DG 80	17.42	14 DAY	4.8	5.5	21.3	5.0	5.3	8.8	4.8	4.8	22.5	5.8	6.0
				LDS (0.05) =	1.0	.7	21.3	.5	.7	10.3	.7	.6	9.1	.7	1.1
				STANDARD DEVIATION =	.7	.5	14.6	.4	.5	7.0	.5	.4	6.2	.5	.7
				COEFF. OF VARIABILITY =	11.7	8.3	70.6	5.9	7.4	63.3	8.5	6.6	36.1	7.6	11.6

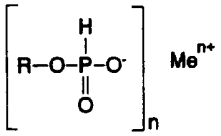
Overall, the results indicate that the combination of ALIETTE™ + FORE™, containing the Pigment Blue 15, provides a better improvement in turf quality and color over other combinations of ALIETTE™ and mancozeb without the Pigment Blue 15. The results demonstrate that the presence of the Pigment Blue 15, enhances the activity of the ALIETTE™ and mancozeb in a synergistic interaction.

The foregoing is illustrative of the present invention and is not to be construed as limiting thereof. The invention is defined by the following claims, with equivalents of the claims to be included therein.

That Which Is Claimed Is:

1. A method of enhancing turf quality in turfgrass which comprises applying to said turfgrass in an amount effective to enhance turf quality:

(a) 1 part by weight of a monoester salt of a phosphorous acid of Formula (I):



(I)

wherein:

R is an alkyl radical having 2 to 4 carbon atoms,

Me is an alkali metal, alkaline earth metal, or aluminum atom, and

n is a whole number from 1 to 3 equal to the valence of Me;

(b) from 1.5 to 2.5 parts by weight of an ethylenebisdithiocarbamate contact fungicide selected from the group consisting of manganese ethylenebisdithiocarbamate and manganese-zinc ethylenebisdithiocarbamate; and

(c) from 0.01 to 0.1 parts by weight of a benzoporphyrin compound.