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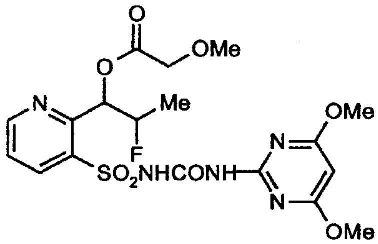
(54) **Title:** SYNERGISTIC HERBICIDAL COMPOSITIONS

(57) **Abstract:** The present invention relates to a synergistic herbicidal composition comprising N- [[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl] -2- [2-fluoro- 1 -(methoxymethylcarbony loxy)propyl] -3 -pyridine sulfonamide or N-[[(4,6-dimethoxy-2-pyrimidinyl)amino] carbonyl]-2-[2-fluoro-l-(hydroxy)propyl]-3-pyridine sulfonamide and other herbicidal active materials as active ingredient. The herbicidal composition of the present invention can increase the herbicidal efficacy against major weeds, and can reduce the use amount of active ingredients per unit area, due to the synergistic effect by mixing two herbicidal active ingredient having different physiological functions or different herbicidal activities.

SYNERGISTIC HERBICIDAL COMPOSITIONS

TECHNICAL FIELD

The present invention relates to a synergistic herbicidal composition comprising a compound of the following formula (1) (N-[[(4,6-dimethoxy-2-pyrimidinyl)amino] carbonyl]-2-[2-fluoro-1-(methoxymethylcarbonyloxy)propyl]-3-pyridine sulfonamide) or a compound of the following formula (2) (N-[[(4,6-dimethoxy-2-pyrimidinyl)amino] carbonyl]-2-[2-fluoro-1-(hydroxy)propyl]-3-pyridine sulfonamide), and other herbicidal active materials having different physiological functions or different herbicidal activities from the compound of the formula (1) or (2), characterized in that herbicidal activity is increased, herbicidal spectrum is wide and the amount of active ingredients used can be saved, compared with a single agent. In particular, the present invention relates to a herbicidal composition comprising the compound of the formula (1) or (2), and one or more other active ingredients selected from the group consisting of photosynthesis inhibitor bentazone, protoporphyrinogen IX oxidase inhibitor carfentrazone-ethyl and auxin-type herbicides, characterized in that herbicidal activity against perennial weeds and sulfonylurea herbicide-resistant weeds is synergistically increased, antagonism for the control of grass weeds, particularly *Echinochloa* species, is avoided or minimized, and safety to rice for foliar application is improved.



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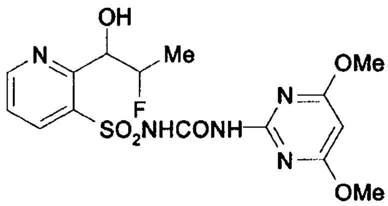


(2)

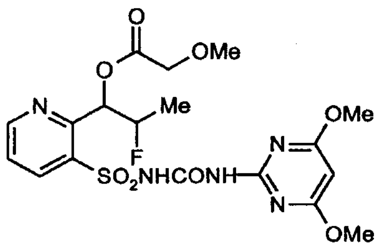
BACKGROUND ART

The present invention relates to a synergistic herbicidal composition comprising N-[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-2-[2-fluoro-1-(methoxymethylcarbonyloxy)propyl]-3-pyridine sulfonamide or N-[[(4,6-dimethoxy-2-pyrimidinyl)amino] carbonyl]-2-[2-fluoro-1-(hydroxy)propyl]-3-pyridine sulfonamide and other herbicidal active materials as active ingredient.

In crop cultivation, it is important to control weeds that inhibit growth of crops and cause yield reduction and to protect crops. In order to reduce damages such as poor growth or yield reduction of crops due to weeds in crop cultivation, some herbicidal active ingredients which can effectively control such weeds and are safe for crops have been developed. A large number of herbicides developed up to now have been registered and used for controlling weeds for certain crops. Herbicides used for controlling weeds in a specific crop cultivation should have a sufficiently high herbicidal activity and a wide herbicidal spectrum, and should be safe enough for environment and crops. However, not all herbicides perfectly satisfy such requirements.

The most frequently used method for increasing herbicidal activity and extending herbicidal spectrum of existing herbicides is to mix two or more herbicidal active materials having different herbicidal activities from each other. In case of mixing two or more herbicidal active materials, more excellent herbicidal efficacy may be exhibited than individual herbicide application (solo application). Like this, when the efficacy of mixture of two of more components is greater than a level expected from those of individual components, we call this “Synergism (synergistic action)”. However, such synergistic action in herbicide mixture of two or more herbicidal active materials can be seen only in some cases. In most cases of mixture, the herbicidal activity is lower than solo application of individual components due to differences of herbicidal properties, absorption rates, translocation, metabolism, etc. “Antagonism (antagonistic effect)” indicates such a case that the herbicidal efficacy of a mixture of two or more herbicidal active materials is lower than solo application of individual components. And, “additive action” indicates a case that the herbicidal efficacy of a mixture of two or more herbicidal active materials is the same as solo application of individual components.

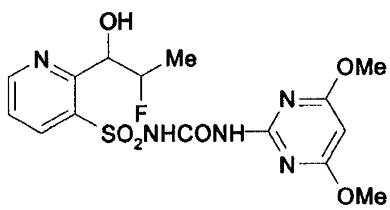
Meanwhile, KR Patent No. 10-0399366 (Application No. 10-2000-0059990) disclosed a herbicidal active material of sulfonylurea herbicide, the compound of the following formula (1) [ISO proposed name: flucetosulfuron].



(1)

Said flucetosulfuron is known to be safe for rice plant, wheat, barley (optimum amount of use: 10~40g a.i./ha) and grass (optimum amount of use: 50~200g a.i./ha), in soil or foliar application, and to have excellent weed control effects for a wide range of weed species such as broad-leaved weeds, grass weeds (*Gramineae*), sedge weeds (*Cyperaceae*), annual and perennial weeds, etc.

KR Patent No. 10-0107924 (Application No. 10-1993-0006915) disclosed another herbicidal active material of sulfonylurea herbicide, N-[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-2-[2-fluoro-1-(hydroxy)propyl]-3-pyridine sulfonamide, the compound of the following formula (2):



(2)

The above compound is known to be effective for preventing monocotyledon or dicotyledon weeds, such as barnyardgrass (*Echinochloa crus-galli*), *Monochoria vaginalis*, or *Sagittaria pygmaea*, and safe for rice plant.

However, it is also reported that when the flucetosulfuron of the formula (1) and N-[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-2-[2-fluoro-1-(hydroxy)propyl]-3-pyridine sulfonamide of the formula (2) are applied to rice field by foliar and soil application, they show low herbicidal efficacy to some grass weeds; sulfonylurea herbicide-resistant ecotypes among *Monochoria vaginalis*, *Scirpus juncoides*, *Lindernia* species, and *Cyperus difformis* evolved due to continuous use of sulfonylurea herbicide for a long-period of time; and some perennial weeds such as *Eleocharis kuroguwai*, *Cyperus serotinus*, *Sagittaria trifolia*, etc. Also, when used in wheat or barley fields by foliar application, they showed low herbicidal efficacy to some grass weeds such as *Alopecurs myosuroides*, *Poa spp.*, etc. and broad-leaved weeds such as *Veronica persica* and *Viola arvensis*. Furthermore, in weed control in turf field, they showed low herbicidal efficacy against *Veronica persica* and *Poa annua*.

Photosynthesis inhibitor is a herbicide showing its herbicidal activity by inhibiting photosynthesis through disturbing or blocking electron transfer in photosynthesis of plant, and is mainly absorbed through treated leaves. This herbicide exhibits immediate effect in treated region, and is frequently used for rice, wheat, and barley since it is relatively safe for grass crops. Bentazone, a representative herbicide of photosynthesis inhibitor, is widely used for wheat, barley, and rice mainly by foliar application, and by soil application only for rice. Bentazone cannot control grass weeds in solo application, and so has been used for the purpose of controlling only broad-leaved weeds. However, in order to control grass weeds, particularly barnyardgrass, bentazone is often used as mixture with graminicide that is a herbicide particularly effective for controlling grass weeds such as Acetyl-CoA carboxylase inhibitor (herbicide inhibiting Acetyl-CoA carboxylase that is an important enzyme in fatty acid biosynthesis, also called as ACCase inhibitor, and chemically divided into aryloxyphenoxy propionic acid and cyclohexanedion, wherein cyhalofop-butyl, etc. belong to the former, and tralcoxydim, etc. to the latter). Its representative example is the mixture of bentazone and cyhalofopbutyl. When graminicide such as cyhalofop-butyl is used in solo application, it has a good preventive effect on grass weeds. However, graminicides such as cyhalofop-butyl is used in a mixture with bentazone, the herbicidal efficacy is often significantly decreased due to antagonism, compared with solo application (Weed Technol. 9, 741 (1995). Thus, development as such mixture has been frequently limited, or efficacy expected from such mixture cannot be sufficiently obtained.

Another example of mixture showing antagonism is reported when propanil of photosynthesis inhibitor is used with pyribenzoxim of acetolactate synthase inhibitor [Pesticide Biochemistry and Physiology, Volume 67, Number 1, May 2000, pp. 46-53(8)]. Generally, a representative example of such antagonistic effect is often reported when a contact-type herbicide, such as photosynthesis inhibitor including bentazone or propanil, or protoporphyrinogen IX oxidase inhibitor including carfentrazone-ethyl, is used as a mixture with a systemic herbicide such as acetyl-CoA carboxylase inhibitor including cyhalofop-butyl, or acetolactate synthase inhibitor [herbicide inhibiting Acetolactate synthase (ALS) that is an important enzyme in biosynthesis of branched-chain amino acid, and chemically divided into sulfonylurea, imidazolinone, triazolopyrimidine, and pyrimidinyl(thio)benzoate, wherein flucetosulfuron belongs to sulfonylurea] including flucetosulfuron (Weed Science, 1989, Vol. 37, No. 3, pp. 400-404), which is a major restriction to the development as mixture.

Herbicide belonging to protoporphyrinogen IX oxidase inhibitor shows its herbicidal activity by inhibiting protoporphyrinogen IX oxidase related to chloroplast biosynthesis, and is mainly absorbed in the treated leaves for its herbicidal action. This herbicide shows immediate effect, but may give damage (phytotoxicity) to crops when sprayed by foliar application, and so its development as foliar applicable herbicide is limited. In particular, carfentrazone-ethyl has been difficult to develop as foliar applicable herbicide for rice due to such damage. In addition, carfentrazone-ethyl has extremely low efficacy to grass weeds, particularly barnyardgrass, and so needs to be used as mixture with other herbicides. However, when used as mixture with other herbicide, the herbicidal efficacy of carfentrazone-ethyl has been often decreased, compared to its solo application due to its antagonistic action (Arkansas Agricultural Experiment Station, B.R. Wells Rice Research Studies 2001, pp. 65-69), and so its development as mixture has been limited.

An auxin herbicide has a similar physiological function to plant hormone auxin, but may disturb the physiological function of plant over certain concentration to show its herbicidal activity. Auxin herbicide has been widely used to control weeds, particularly broad-leaved weeds. However, when this auxin herbicide, particularly 2,4-D, MCPA, MCPB, etc., is used for rice plant by foliar or soil application, if the application timing is not correct or the amount of use is over optimum use rate, it is generally known to cause a severe damage to rice enough to lead yield reduction. For example, in case of 2,4-D, it is recommended to use at the optimum application rate of 280 g a.i./ha during the period between effective tillering stage and panicle initiation (Korean Crop Protection Association, 2004, Pesticide Use Manual, 741p). Due to such rice damage, although the auxin herbicide has been used for a long time, but its development and usage as herbicide for rice has been limited. Furthermore, when this herbicide is used as mixture with other herbicides, its herbicidal efficacy is decreased because of antagonism, and so its development as mixture has also been limited.

SUMMARY OF THE INVENTION

To increase the herbicidal activity and extend the herbicidal spectrum of flucetosulfuron of the formula (1) and N-[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-2-[2-fluoro-1-(hydroxy)propyl]-3-pyridine sulfonamide of the formula (2), the present inventors selected herbicidal active ingredients having complementary properties, based on individual herbicidal activity, and confirmed them by biological examination. Selection of the herbicidal active ingredients having complementary properties was made by dividing them into ones having different biochemical functions and ones having different herbicidal spectrums from flucetosulfuron or the compound of the formula (2), and further dividing them into ones having special effects on grass weeds, broad-leaved weeds or sulfonylurea- resistant weeds, and perennial weeds. As a result, surprisingly, it is discovered that when a composition comprising such herbicidal active ingredients having complementary properties is mixed with flucetosulfuron or the compound of the formula (2), the composition exhibits synergistic action enough to clearly show increased herbicidal activity and extended herbicidal spectrum, and some mixtures exhibit less damage as well as such synergistic action on grass weeds, to complete the present invention.

Therefore, it is an object of the present invention to provide a herbicidal composition, characterized in that less amounts of herbicidal ingredients can be used due to their increased herbicidal activity and extended herbicidal spectrum, compared to sole application of flucetosulfuron of the formula (1) or N-[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-2-[2-fluoro-1-(hydroxy)propyl]-3-pyridine sulfonamide of the formula (2), or herbicidal active materials selected as a partner for mixture, and the cost for weed control can be saved by reducing labor for herbicide application by co-application of flucetosulfuron of the formula (1) or the compound of the formula (2) with other herbicidal active materials contained in the herbicidal composition. Another object of the present invention is to provide a herbicidal composition, characterized in that by co-application of flucetosulfuron of the formula (1) or the compound of the formula (2) with some herbicidal active materials which particularly have significantly decreased effects on specific weeds due to antagonism when used as mixture with other herbicides, or limited use due to crop damage when used as solo application, among existing herbicides, reduced herbicidal activity to the specific weed can be solved, the herbicidal activity on *Eleocharis kuroguwai* or resistant weed which is difficult to control can be increased, and the crop safety can be increased by application as mixture rather than individual solo application.

DISCLOSURE OF THE INVENTION

To achieve the above objects, the present invention provides a herbicidal composition comprising N-[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-2-[2-fluoro-1-(methoxymethylcarbonyloxy)propyl]-3-pyridine sulfonamide of the above formula (1), i.e., flucetosulfuron [herbicidal active ingredient (A1), below] or the compound of the above formula (2), N-[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-2-[2-fluoro-1-(hydroxy)propyl]-3-pyridine sulfonamide [herbicidal active ingredient (A2), below], and other herbicidal active ingredient [herbicidal active ingredient (B), below].

Therefore, the present invention relates to a herbicidal composition, comprising herbicidal active ingredient (A1) or (A2) basically, and herbicidal active ingredient (B), wherein (A1) is flucetosulfuron (N-[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-2-[2-fluoro-1-(methoxymethylcarbonyloxy)propyl]-3-pyridine sulfonamide); (A2) is N-[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-2-[2-fluoro-1-(hydroxy)propyl]-3-pyridine sulfonamide; and (B) is one or more herbicides selected from the compound group (B1 to B9) consisting of the following herbicides, having different chemical structure or biological herbicidal activity from herbicide (A1) or (A2) contained in each case.

Suitable partners (B) for mixture may be any compounds which belong to the following sub-groups (B1) to (B9). The names of most herbicides are from their general names for active compounds according to "The Pesticide Manual," 12th edition, 2000, British Crop Protection Council (PM, below), and separate references are shown for some herbicides.

<u>(B1) Acetyl-CoA carboxylase inhibitor</u>

(B1.1) Diclofop and ester thereof, in particular, methyl ester (PM, pp. 279-280)

(B1.2) Metamifop (Proceedings of the BCPC International Congress-Crop Science & Technology 2003, pp. 85-92)

(B1.3) Cyhalofop-butyl (PM, pp. 223-224)

(B1.4) Clodinafop-propargyl (PM, pp. 186-187)

(B1.5) Fenoxaprop-P and ester thereof, in particular, ethyl ester (PM, pp. 393-394)

(B1.6) Flamprop-M and ester thereof (PM, pp. 415-416)

(B1.7) Tralcoxydim (PM, pp. 914-915)

(B1.8) Profoxydim(PM, pp. 61-62)

(B2) Acetolactate synthase inhibitor

(B2.1) Thifensulfuron-methyl (PM, pp. 899-900)

(B2.2) Metsulfuron-methyl (PM, pp. 644-645)

(B2.3) Prosulfuron (PM, pp. 787-788)

(B2.4) Tribenuron-methyl (PM, pp. 928-929)

(B2.5) Mesosulfuron-methyl (Proceedings of the BCPC Conference - Weeds 2001, pp. 43-48)

(B2.6) Flazasulfuron (PM, pp. 417-418)

(B2.7) Sulfosulfuron (PM, pp. 853-854)

(B2.8) Iodosulfuron and ester thereof, in particular, methyl ester (PM, pp. 547-548)

(B2.9) Flupyrsulfuron and ester thereof, in particular, methyl ester (PM, pp.

447-448)

(B2.10) Bensulfuron and ester thereof, in particular, methyl ester (PM, pp. 76-77)

(B2.11) Cyclosulfamuron (PM, pp. 217-218)

(B2.12) Cinosulfuron (PM, pp. 183-184)

(B2.13) Azimsulfuron (PM, pp. 48-49)

(B2.14) Imazosulfuron (PM, pp. 534-544)

(B2.15) Pyrazosulfuron-ethyl (PM, pp. 795-797)

(B2.16) Penoxulam (Proceedings of the BCPC International Congress-Crop Science & Technology 2003, pp. 85-92)

(B2.17) Florasulam (PM, pp. 420-421)

(B2.18) Bispyribac-sodium (PM, pp. 97-98)

(B2.19) Pyribenzoxim (PM, pp. 801)

(B3) Photosynthesis inhibitor

(B3.1) Bentazone (PM, pp. 80-81)

(B3.2) Bromoxynil or bromoxynil-octanoate (PM, pp. 110-112)

(B3.3) Ioxynil, and ester and salt thereof (PM, pp. 548-550)

(B3.4) Terbutryn (PM, pp. 883-884)

(B3.5) Simetryn (PM, pp. 837-834)

(B3.6) Chlorotoluron (PM, pp. 169-170)

(B3.7) Isoproturon (PM, pp. 559-560)

(B4) Protoporphyrinogen IX oxidase inhibitor

(B4.1) Oxyfluorfen (PM, pp. 702-703)

(B4.2) Pyraflufen-ethyl (PM, pp. 792-793)

(B4.3) Carfentrazone-ethyl (PM, pp. 141-142)

(B4.4) Cinidon-ethyl (PM, pp. 181-182)

(B4.5) Oxadiargyl (PM, pp. 690-691)

(B4.6) Pentoxazone (PM, pp. 718-719)

(B5) Carotenoid biosynthesis inhibitor

(B5.1) Diflufenican (PM, pp. 296-297)

(B5.2) Picolinafen (PM, pp. 742-743)

(B5.3) Mesotrione (PM, pp. 602)

(B5.4) Pyrazoxyfen (PM, pp. 797-798)

(B5.5) Pyrazolate (PM, pp. 793-794)

(B5.6) Benzobicyclon (PM, pp. 82)

(B5.7) Clomazone (PM, pp. 190-191)

(B6) Cell wall synthesis inhibitor

(B6.1) Butachlor (PM, pp. 117-118)

(B6.2) Flufenacet (PM, pp. 434-435)

(B6.3) Mefenacet (PM, pp. 593-594)

(B6.4) Fentrazamide (PM, pp. 406-407)

(B6.5) Pretilachlor (PM, pp. 755-756)

(B6.6) Carfenstrole (cafenstrole, PM, pp. 128-129)

(B6.7) Isoxaben (PM, pp. 561-562)

(B7) Lipid biosynthesis inhibitor

(B7.1) Benfuresate (PM, pp. 71-72)

(B7.2) Ethofumesate (PM, pp. 364-365)

(B7.3) Prosulfocarb (PM, pp. 786-787)

(B7.4) Triallate (PM, pp. 921-922)

(B7.5) Thiobencarb (PM, pp. 901-902)

(B8) Auxin herbicide

(B8.1) Triclopyr (PM, 933-934)

(B8.2) Fluroxypyr and ester thereof (PM, pp. 455-457)

(B8.3) 2,4-D and ester thereof (PM, pp. 243-246)

(B8.4) MCPA and ester thereof, in particular, thioethyl (PM, pp. 583-586)

(B8.5) MCPB and ester thereof, in particular, ethyl ester (PM, pp. 586-588)

(B8.6) Mecoprop and its pure R-isomer, mecoprop-P (PM, pp. 489-592)

(B8.7) Clomeprop (PM, pp. 191-192)

(B8.8) Dicamba (PM, pp. 265-267)

(B9) others

(B9.1) Pendimethalin (PM, pp. 714-715)

(B9.2) Dithiopyr (PM, pp. 330)

(B9.3) Difenzoquat-methyl sulfate (PM, pp. 291-292)

(B9.4) Bromobutide (PM, pp. 108)

(B9.5) Indanofan (PM, pp. 543-544)

(B9.6) Pyributicarb (PM, pp. 802)

Synergistic action obtained by mixing and using herbicidal active ingredients (A1) or (A2) and (B) in one composition according to the present invention can be often observed when these active ingredients are sprayed at different times.

The treatment amounts of herbicidal active ingredients (A1) and (A2) which are commonly contained in the herbicidal composition of the present invention may vary depending on subject crops, but the amount of active ingredient per hectare (ha) is from 20g to 300g. The composition of the present invention needs to have a lower treatment amount for certain active ingredient than individual application case.

Therefore, in the composition of the present invention, the treatment amount of herbicidal active ingredient per hectare generally should be 1 to 300g, preferably 10 to 200g, for active ingredient (A), and 1 to 4000g, preferably 2 to 2000g, for active ingredient B. The weight ratio of A:B used in the composition may vary in a wide range, preferably in the range of 1:200 to 200:1, more preferably in the range of 1:100 to 20:1, but not limited thereto. The final weight ratio may vary depending on specific application field, weed spectrum, and combination of active compounds to be used, and may be determined in pre-test.

The composition of the present invention can be used in crop fields to selectively control annul and perennial grass weeds, sedge weeds, and broad-leaved weeds. The above crop fields include rice cultivations, cereals (wheat, barley, oats, rye, etc.) cultivations, and grass or pasture. Furthermore, the composition also can be used to control unwanted weeds in non-cropping area, in particular, railroad tracks or banks around rice fields.

The composition of the present invention can be used in crop fields and non-cropping area without limit by any conventional application methods such as soil application, water surface application, foliar application, etc., and preferably by foliar application.

Among the compositions according to the present invention, compared with the application of a composition comprising only active ingredient (A1) or (A2) as herbicidal active compound, the following compounds are selected from active ingredient (B) as ingredients having higher activity on broad-leaves weeds to complement herbicidal activity on some major broad-leaves weeds, for example, *Veronica persica*, *Viola arvensis*, *Galium aparine*, *Papaver rhoeas*, etc.:

(B2.1) thifensulfuron-methyl, (B2.2) metsulfuron-methyl, (B2.3) prosulfuron, (B2.4) tribenuron-methyl, (B2.16) penoxulam, (B2.17) florasulam, (B3.1) bentazone, (B3.2) bromoxynil, (B3.3) ioxynil, (B3.5) simetryne, (B4.1) oxifluorfen, (B4.2) pyraflufen-ethyl, (B4.3) carfentrazone-ethyl, (B4.4) cinidon-ethyl, (B4.5) oxadiargyl, (B4.6) pentoxazone, (B5.1) diflufenican, (B5.2) picolinafen, (B5.3) mesotrione, (B5.5) pyrazolate, (B5.6) benzobicyclon, (B5.7) clomazone, (B6.1) butachlor, (B6.3) mefenacet, (B6.4) fentrazamide, (B6.5) pretilachlor, (B6.6) carfenstrole, (B6.7) isoxaben, (B7.5) thiobencarb, (B8.1) triclopyr, (B8.2) fluroxypyr, (B8.3) 2,4-D, (B8.4) MCPA, (B8.5) MCPB, (B8.6) mecoprop or mecoprop-P, (B8.7) clomeprop, (B8.8) dicamba, (B9.2) dithiopyr, (B9.4) bromobutide, (B9.5) indanofan, (B9.6) pyributicarb.

Among the compositions according to the present invention, compared with the application of a composition comprising only active ingredient (A1) or (A2) as herbicidal active compound, the following compounds are selected from active ingredient (B) as ingredients having higher activity on perennial weeds to complement herbicidal activity on some perennial weeds, in particular, *Eleocharis kuroguwai, Scirpus planiculmis, Cyperus serotinus* and *Sagittaria trifolia*:

(B2.10) bensulfuron-methyl, (B2.11) cyclosulfamuron, (B2.12) cinosulfuron, (B2.13) azimsulfuron, (B2.14) imazosulfuron, (B2.15) pyrazosulfuron-ethyl, (B3.1) bentazone, (B4.3) carfentrazole-ethyl, (B5.4) pyrazoxyfen, (B5.5) pyrazolate, (B7.1) benfuresate, (B8.3) 2,4-D or ester, (B8.4) MCPA or ester, thioethyl, (B8.5) MCPB or ester, ethylester.

Also, among the compositions according to the present invention, compared with the application of a composition comprising only active ingredient (A1) or (A2) as herbicidal active compound, the following compounds are selected from active ingredient

(B) as ingredients having higher activity on grass weeds to complement herbicidal activity on some grass weeds:

(B1.1) diclofop-methyl, (B1.2) metamifop, (B1.3) cyhalofop-butyl, (B1.4) clodinafop-propargyl, (B1.5) fenoxaprop-P-ethyl, (B1.6) flamprop-M, (B1.7) tralcoxydim, (B1.8) profoxydim, (B2.5) mesosulfuron-methyl, (B2.6) flazasulfuron, (B2.7) sulfosulfuron, (B2.8) iodosulfuron-methyl, (B2.9) flupyrsulfuron-methyl, (B2.18) bispyribac-sodium, (B2.19) pyribenzoxim, (B3.4) terbutryn, (B3.6) chlorotoluron, (B3.7) isoproturon, (B6.2) flufenacet, (B7.2) ethofumesate, (B7.3) prosulfocarb, (B7.4) triallate, (B9.1) pendimethalin, (B9.3) difenzoquat methylsulfate.

Also, among the compositions according to the present invention, compared with the application of a composition comprising only active ingredient (A1) or (A2) as herbicidal active compound, the following compounds are selected from active ingredient (B) as ingredients having higher herbicidal activity on resistant weeds to complement herbicidal activity on some sulfonylurea herbicide-resistant weeds, for example, resistant *Monochoria vaginalis*, *Lindernia* species, *Scirpus juncoides* and *Cyperus difformis*:

(B3.1) bentazone, (B3.2) bromoxynil, (B3.5) simetryne, (B4.1) oxyfluorfen, (B4.2) pyraflufen-ethyl, (B4.3) carfentrazone-ethyl, (B4.4) cinidon-ethyl, (B4.5) oxadiargyl, (B4.6) pentoxazone, (B5.1) diflufenican, (B5.2) picolinafen, (B5.3) mosotrione, (B5.5) pyrazolate, (B5.6) benzobicyclon, (B5.7) clomazone, (B6.1) butachlor, (B6.3) mefenacet, (B6.4) fentrazamide, (B6.5) pretilachlor, (B6.6) carfenstrole, (B6.7) isoxaben, (B7.5) thiobencarb, (B8.1) triclopyr, (B8.2) fluroxypyr, (B8.3) 2,4-D, (B8.4) MCPA, (B8.5) MCPB, (B8.6) mecoprop or mecoprop-P, (B8.7) clomeprop, (B8.8) dicamba, (B9.2) dithiopyr, (B9.4) bromobutide, (B9.5) indanofan, (B9.6) pyributicarb.

Also, among the compositions according to the present invention, the following compounds are selected from active ingredient (B) to be used as mixture with a composition comprising only active ingredient (A1) or (A2) as herbicidal active compound to solve antagonistic action on certain weeds, in particular, barnyardgrass (Echinochloa crus-galli), which was often observed in other mixtures, to increase herbicidal activity on resistant weeds as well as perennial *Eleocharis kuroguwai*, and to increase safety to rice for foliar application:

(B3.1) bentazone, (B4.3) carfentrazone-ethyl, (B8.2) fluroxypyr, (B8.3) 2,4-D, (B8.4) MCPA, (B8.5) MCPB, (B8.6) mecoprop or mecoprop-P, (B8.7) clomeprop, (B8.8) dicamba.

Furthermore, the herbicidal composition of the present invention may comprise other components, if necessary, for example, one or more selected from the group consisting of other herbicides, insecticides, fungicides, safener (compound used to reduce crop damage by herbicide), and plant growth regulator. These other components may be used as one formulation by co-formulating, mixed and used in a spray tank by separate formulating, or used sequentially.

Furthermore, the herbicidal composition of the present invention may be formulated with carriers, surfactants or additives which are conveniently used in the art of formulation. For example, they may be processed into non-reforming form according to conventional methods, and active ingredients are uniformly mixed with extenders (e.g.: solvents, solid carriers and surfactants, if necessary), processed into wettable powder, suspension concentrate, water dispersible granule, granule, flowable, tablet, jumbo formulations, etc, by such processes as grinding, granulating, tabletting, etc., and then applied to soil and water surface, or foliage of plant.

Suitable carriers and additives may be solid or liquid, including components useful in the art of formulation, for example, natural or synthetic inorganic materials, solvents, dispersing agent, wetting agent, rheology modifier, binders, adjuvant, etc.

Solvents may include aromatic carbohydrate, for example, xylene mixture, or alcohol and glycol, and ether and ester thereof, such as substituted naphthalene ethanol, ethylene glycol, ethylene glycol monomethyl ether or ethylene glycol monoethyl ether; ketone such as cyclo hexanon; strong polar solvents such as *N*-methyl-2-pyrrolidone, dimethylsulfoxide or dimethylformamide; epoxidated or non-epoxidated vegetable oil such as epoxidated coconut oil or soybean oil; water, etc. These solvents may be used as solvents for liquid-type formulation or supplementary solvents for granule-type formulation.

Solid carriers may include minutely grinded natural or synthetic inorganic mineral such as talc, kaolin, bentonite, calcium carbonate, diatomite, or agalmatolite.

Dispersing agents may include anionic dispersing agent such as salts of lignin sulfonic acid, salts of naphthalene sulfonic acid, salts of lauryl sulphuric acid, salts of lauryl sulfonic acid, and salts of polyoxyalkylene alkyl ether sulfate; polyoxyalkylene alkyl aryl ether; polyoxyalkylene alkyl ether; etc. Dispersing agents are not limited to those described above, and may be selected from non-ionic surfactants and anionic surfactants, or cationic surfactants, if necessary.

Wetting agents may include anionic wetting agent such as sodium lauryl surfate, salts of polyoxyalkylene alkylphenyl ether sulfonic acid, salts of dialkyl sulfosuccinate, salts of dialkyl naphthalene sulfonic acid, salts of polyoxyalkylene alkyl ether sulfate; acetylene family non-ionic surfactants; urea complex of non-ionic surfactants, etc.

Suitable rheology modifier may be divided into polysaccharide such as homo-type saccharide and hetero-type saccharide, and inorganic materials such as montmorillorite, smectite, sepiolite, hectoliter, and hydrophilic/hydrophobic silica. The homo-type saccharide may be furan gum, and the hetero-type saccharide may be guar gum, xanthan gum, wellan gum, etc.

Suitable binders may include starch, dextrin, alpha starch, sodium alginate, Arabia gum, gelatin, lignin sulfonate, glucose, sorbitol, polyethylene glycol, hydroxypropyl cellulose (HPC), hydroxypropyl methyl cellulose, polyvinyl pyrrolidone, etc.

Adjuvant refers to materials added in the formulation process to increase chemical effects, or diluted in the preparation process of spray solution. Anionic surfactants, cationic surfactants, non-ionic surfactants, etc., are commonly used as adjuvant. Suitable adjuvant may include salts of dialkyl sulfosuccinate, acetylene family non-ionic surfactants, polyoxyalkylene alkyl ether, polyoxyalkylene alkylphenol ether, polyoxyethylene alkylamine, ethoxylated sorbitan ester, polyoxyethylene fatty acid ester, polyoxyethylene-polyoxypropylene-polyoxyethylene triblock copolymer, alkoxylated trisiloxane, etc.

The following examples are to exemplify the effects of the compositions of the present invention, but the scope of the present invention should not be construed to be limited thereby in any manner.

Example

One example of the formulation according to the invention is as follows.

10 parts (10% w/w) of a mixture of herbicidal active ingredient (A1 or A2)/herbicidal active ingredient (B), 2 parts (2% w/w) of sodium dodecyl sulfate (commercial name: NK-SDS, Coseal), 8 parts (8% w/w) of sodium lignin sulfonate (commercial name: NK-SLS, Coseal), and 80 parts (80% w/w) of kaolin were mixed, and then grinded by using a hammer mill (model name: KDW-1, PAUDAL) to have an average particle size of 5~10μ, to give a wettable powder.

10 parts (10% w/w) of a mixture of herbicidal active ingredient (A1 or A2)/herbicidal active ingredient (B), 1 part of sodium dodecyl sulfate (commercial name: NK-SDS, Coseal), 3 parts (3% w/w) of sodium naphthalene-formaldehyde condensate (commercial name: Morwet-D425, Whittko), 5 parts (5% w/w) of propylene glycol, 0.5 part (0.5% w/w) of bentonite of gel-grade (commercial name: NK-KNP, Coseal), and 80.5 parts (80.5% w/w) of purified water were mixed, and then grinded by using DYNO mill (model name: Typ KDL A) to have an average particle size of 2~3 μ, to give a suspension concentrate.

10 parts (10% w/w) of a mixture of herbicidal active ingredient (A1 or A2)/herbicidal active ingredient (B), 5 parts (5% w/w) of calcium dodecyl benzene sulfonate (commercial name: CR-DBC64, Yusungwhayeontech), 2.5 parts (2.5% w/w) of ethoxylated (average EO addition mole number: 10) oleyl alcohol (commercial name: Koremul OE10, Hannongwhasung), 2.5 parts (2.5% w/w) of ethoxylated (average EO addition mole number: 40) castor oil (commercial name: Koremul CO40, Hannongwhasung), and alkyl benzene family naphtha solvent (commercial name: Kocosol 150, SK Corp.) were uniformly mixed by using an appropriate mixer, to give an emulsifiable concentrate.

Biological Example

The method for evaluating synergistic herbicidal activity and safety on crops by mixed treatment of active ingredient (A1) or (A2) and one or more active ingredients (B) selected from the group consisting of active ingredients (B1) to (B9), and results thereof are as follows.

1. Greenhouse pot test

Seeds or parts of reserve organ (propagule; tuber, stem, etc) of monocotyledon weeds (*Gramineae* and *Cyperaceae*) and dicotyledon weeds (broad-leaved weed) were seeded or transplanted into sandy loam soil in pot, and then grown under proper greenhouse growth conditions (temperature, atmosphere humidity, and irrigation). For the test under the conditions of paddy rice cultivation, the water was maintained at 3cm.

After a certain period of time from seeding or transplantation, when the growth of the test plants reached a certain stage, the composition of this invention was treated thereto. In the case of soil application, the composition in fixed amount was directly applied to flooded soil. In the case of foliar application, irrigated water was drained therefrom, and then the composition in fixed amount was diluted with water and sprayed to the test plants by using CO_2 pressurized belt-driven sprayer (R&D spray, USA) to deliver the spray solution of 200 to 1000L/ha. Then, the treated plants were maintained in greenhouse under the standard greenhouse growth conditions for about 3 to 4 weeks. Visual assessment was then made to evaluate the herbicidal efficacy of the composition on the treated plants in comparison with untreated control. The herbicidal efficacy of the composition was recorded by % weed control, and was rated by 0% to 100% in comparison with untreated control. 0% means no effect on weeds, and 100% means complete death of weeds. Each treatment consisted of three or four replicates.

2. Field test

Crops were seeded or transplanted under field conditions where they can normally grow, and at the same time, seeds or propagules (tuber, stem, etc) of monocotyledon and dicotyledon were seeded or transplanted into plots placed in the field to grow them, or uniformly and naturally established weeds were grown to a certain growth stage in the field. When the growth of these weeds reached a certain stage, the composition of this invention was treated. In the case of soil application, the composition in fixed amount was directly applied to flooded soil. In the case of foliar application, the composition in fixed amount was immediately diluted with water, and sprayed to the test plants by using a CO_2 pressurized knapsack sprayer to deliver 200 to 1000L ha^{-1} of diluted solution. Prior to foliar application, irrigated water was drained in the paddy condition. After about 5 to 7 weeks from the application of the composition, the herbicidal efficacy and phytotoxicity were measured by the visual evaluation in comparison with untreated control by the same scale as used in the above greenhouse pot test. Each treatment consisted of three or four replicates.

3. Evaluation of synergistic effects

In cased of using the herbicidal composition of the invention, its herbicidal efficacy against weeds exceeds the sum of individual herbicidal efficacies when each herbicidal compound contained in the present composition is independently sprayed. Therefore, it was observed that the composition of this invention provided the same herbicidal efficacy against weeds with a lower rate of herbicidal compound, compared to individual application of each herbicidal compound. Such increase in herbicidal activity and efficacy or decrease in the treatment rate of active ingredient can be the strong evidence to show synergistic effects of this invention. The evaluation of synergistic effects shown in mixed application of two or more herbicidal active ingredients was determined based on Colby's method described in "Calculation Synergistic and Antagonistic Response of Herbicide Combinations" (Weeds 15/1 (1967) by S.R. Colby).

Therefore, the following formula was used for this purpose:

$$E = X + Y - \left(\frac{X \times Y}{100} \right)$$

wherein X indicates weed control (%) by the herbicide A at a dose of X g a.i. ha^{-1}, Y indicates weed control (%) by the herbicide B at a dose of Y g a.i. ha^{-1}, and E indicates expected value in weed control (%) at a dose of X+Y g a.i. ha^{-1}.

If the actual weed control value observed in the biological test exceeds the expected value (E) calculated by using the Colby's method, it means that the efficacy of the herbicidal composition is greater than the sum of efficacies of individual components, which means that the composition has synergistic effect.

4. Evaluation of increased crop safety

The crop safety is described by the term of "crop phytotoxicity," which means damage on crop, and so a lower degree of phytotoxicity to crop means higher safety on crop. The Crop phytotoxicity of the herbicidal composition of the present invention is lower than the sum of crop phytotoxicities of individual herbicidal compounds contained in the composition when independently sprayed. Therefore, the composition of the invention has higher safety on crops, compared with compositions comprising individual herbicidal active ingredients, and so the crop phytotoxicity occurred in a single component application is significantly decreased enough to use for subject crops. Such increase in safety can be calculated by the above Colby's method. If actual crop phytotoxicty (%) observed in the mixture is lower than expected value (E) calculated by the Colby method, it means that the mixture has lower phytotoxicity than the sum of individual components, i.e. the composition has synergistic safety effect.

The results of the above tests are shown in the following Tables 1 to 26.

Table 1

Herbicidal performance of compound (A1) and diclofop (B1.1) against grass weed, *Poa annua* in the field (by foliar application)

Compound / Dose (g a.i. ha^{-1})		% weed control	
		Poa annua	
A1	B1.1	Observed	Expected
7.5	-	0	-
-	125	26.7	-
7.5	125	53.3	26.7

Table 2

Herbicidal performance of compound (A1) and metamifop (B1.2) against grass weeds in the field (by foliar application)

Compound / Dose (g a.i. ha^{-1})		% weed control			
		Alopecurs myosuroides		*Avena fatua*	
A1	B1.2	Observed	Expected	Observed	Expected
40	-	33	-	0	-
-	50	21.7	-	37	-
40	50	63.3	48	51.7	37

Table 3

Herbicidal performance of compound (A1) and clodinafop (B1.4) against grass weed, *Poa annua* in the field (by foliar application)

Compound / Dose (g a.i. ha^{-1})		% weed control	
		Poa annua	
A1	B1.4	Observed	Expected
30	-	13.3	-
-	30	46.7	-
30	30	100	53.8

Table 4

Herbicidal performance of compound (A1) and thifensulfuron (B2.1) against broad-leaved weeds in the field (by foliar application)

Compound / Dose (g a.i. ha^{-1})		% weed control							
		Viola arvensis		*Galium aparine*		*Papaver rhoeas*		*Veronica persica*	
A1	B2.1	Observed	Expected	Observed	Expected	Observed	Expected	Observed	Expected
15	-	10	-	56.7	-	6.7	-	10	-
30	-	-	-	70	-	30	-	-	-
-	11.25	33.3	-	26.7	-	46.7	-	53.3	-
15	11.25	53.3	40.0	80	68.3	66.7	50.3	66.7	58
30	11.25	-	-	86.7	78.0	80	62.7	-	-

Table 5

Herbicidal performance of compound (A1) and flupyrsulfuron (B2.9) against grass weed, *Alopecurs myosuroides* in the field (by foliar application)

Compound / Dose (g a.i. ha^{-1})	% weed control

		Alopecurs myosuroides	
A1	B2.9	Observed	Expected
15	-	6.7	-
-	5	86.7	-
15	5	100	87.6

Table 6

Herbicidal performance of compound (A1) and bensulfuron-methyl (B2.10) against perennial weed, *Eleocharis kuroguwai* in the greenhouse (by soil application)

Compound / Dose (g a.i. ha^{-1})		% weed control *Eleocharis kuroguwai*	
A1	B2.10	Observed	Expected
12	-	0	-
15	-	6.7	-
18	-	6.7	-
21	-	31.7	-
-	54	45	-
12	54	71.7	45
15	54	81.7	48.7
18	54	93.3	48.7
21	54	91.7	62.4

Table 7

Herbicidal performance of compound (A1) and cyclosulfamuron (B2.11) against perennial weeds in the greenhouse (by soil application)

Compound / Dose (g a.i. ha^{-1})	% weed control	
	Eleocharis kuroguwai	*Cyperus serotinus*

A1	B2.11	Observed	Expected	Observed	Expected
15	-	35	-	12	-
18	-	48	-	22	-
21	-	58	-	33	-
-	60	68.3	-	63.3	-
15	60	90	79.4	83.3	67.7
18	60	91.7	83.5	100	71.4
21	60	93.3	86.7	100	75.4

Table 8

Herbicidal performance of compound (A1) and cinosulfuron (B2.12) against perennial weed, *Eleocharis kuroguwai* in the greenhouse (by soil application)

Compound / Dose (g a.i. ha^{-1})		% weed control *Eleocharis kuroguwai*	
A1	B2.12	Observed	Expected
12	-	0	-
15	-	0	-
18	-	26.7	-
21	-	26.7	-
-	24	50	-
12	24	70	50
15	24	78.3	50
18	24	80	63.4
21	24	80	63.4

Table 9

Herbicidal performance of compound (A1) and azimsulfuron (B2.13) against perennial weeds in the greenhouse (by soil application)

Compound / Dose (g a.i. ha^{-1})		% weed control			
		Eleocharis kuroguwai		*Cyperus serotinus*	
A1	B2.13	Observed	Expected	Observed	Expected
18	-	50.7	-	0	-
21	-	41.3	-	0	-
-	15	86.7	-	95	-
18	15	94.7	93.4	100	95
21	15	100	92.2	97	95

Table 10

Herbicidal performance of compound (A1) and pyrazosulfuron-ethyl (B2.15) against perennial weed, *Cyperus serotinus* in the greenhouse (by soil application)

Compound / Dose (g a.i. ha^{-1})		% weed control	
		Cyperus serotinus	
A1	B2.15	Observed	Expected
20	-25	-	-
40	-	40	-
-	20	72	-
20	20	85	79
40	20	92.5	83.2

Table 11

Herbicidal performance of compound (A1) and bentazone (B3.1) against *Eleocharis kuroguwai*, barnyardgrass (*Echinochloa crus-galli*), and rice in the field (by foliar application)

Compound / Dose (g a.i. ha^{-1})		% weed control				% Phytotoxicity	
		Eleocharis kuroguwai		Barnyardgrass		Rice	
A1	B3.1	Observed	Expected	Observed	Expected	Observed	Expected

30	-	60	-	95	-	20	--
40	-	70	-	95	-	25	-
-	1650	35	-	0	-	0	-
30	1650	80	74	90	95	10	20
40	1650	90	81	93	95	15	25
Cyhalofop-butyl + bentazone (300+1650)		25		55		0	

Table 12

Herbicidal performance of compound (A1) and simetryn (B3.5) against sulfonylurea herbicide-resistant weeds in the greenhouse (by soil application)

Compound / Dose (g a.i. ha^{-1})		% weed control			
		Resistant *Rotala indica*		Resistant *Cyperus difformis*	
A1	B3.5	Observed	Expected	Observed	Expected
21	-	16.7	-	58.3	-
-	135	67.5	-	72.5	-
21	135	81.7	72.9	98.3	88.5

Table 13

Herbicidal performance of compound (A1) and carfentrazone-ethyl (B4.3) against major rice weeds, and rice in the field (by foliar application)

Compound / Dose (g a.i. ha^{-1})		% weed control						% Phytotoxicity	
		Eleocharis kuroguwai		*Monochoria vaginalis*		Baryardgrass		Rice	
A1	B4.3	Observed	Expected	Observed	Expected	Observed	Expected	Observed	Expected
45	-	70	-	88	-	65	-	0	-
60	-	80	-	95	-	70	-	10	-

-	45	40	-	30	-	0	-	10	-
-	60	40	-	40	-	0	-	30	-
45	45	98	82	100	91.6	70	65	0	10
60	60	95	88	100	97	75	70	0	37

Table 14

Herbicidal performance of compound (A1) and carfentrazone-ethyl (B4.3) against broad-leaved weed, *Monochoria vaginalis* in the greenhouse (by foliar application)

Compound / Dose (g a.i. ha^{-1})		% weed control *Monochoria vaginalis*	
A1	B4.3	Observed	Expected
7.5	-	1.9	-
15	-	45.4	-
30	-	51.8	-
45	-	80.5	-
-	30	47.2	-
7.5	30	74.8	48.2
15	30	78.5	71.2
30	30	83.5	74.6
45	30	98.2	89.7

Table 15

Herbicidal performance of compound (A1) and carfentrazone-ethyl (B4.3) against major weed, clover (*Trifolium repens*) in a turf field (by foliar application)

Compound / Dose (g a.i. ha^{-1})		% weed control against clover			
		24 DAA*		38 DAA	
A1	B4.3	Observed	Expected	Observed	Expected

50	-	60	-	83	-
-	37.5	25	-	20	-
-	75.0	70	-	45	-
50	37.5	93	70	94	86.4
50	75.0	94	88	98	90.7

*DAA: days after application

Table 16

Herbicidal performance of compound (A1) and carfentrazone-ethyl (B4.3) against broad-leaved weeds in the field (by foliar application)

Compound / Dose (g a.i. ha^{-1})		% weed control							
		Viola arvensis		*Galium aparine*		*Papaver rhoeas*		*Veronica persica*	
A1	B4.3	Observed	Expected	Observed	Expected	Observed	Expected	Observed	Expected
15	-	10	-	56.7	-	6.7	-	10	-
30	-	50	-	70	-	30	-	6.7	-
-	10	0	-	33.3	-	6.7	-	26.7	-
15	10	73.3	10	80	71.1	33.3	13	66.7	34
30	10	80	50	100	80.0	46.7	34.7	63.3	31.6

Table 17

Herbicidal performance of compound (A1) and pentoxazone (B4.6) against sulfonylurea herbicide-resistant weeds in the greenhouse (by soil application)

Compound / Dose (g a.i. ha^{-1})		% weed control					
		Resistant *Monochoria vaginalis*		Resistant *Lindernia procumbens*		Resistant *Cyperus difformis*	
A1	B5.1	Observed	Expected	Observed	Expected	Observed	Expected
21	-	31.7	-	50	-	58.3	-
-	240	62.5	-	82.5	-	75	-

21	240	74.4	95	93.3	91.3	100	89.6

Table 18

Herbicidal performance of compound (A1) and diflufenican (B5.1) against broad-leaved weeds in the field (by foliar application)

Compound / Dose (g a.i. ha^{-1})		% weed control					
		Viola arvensis		*Galium aparine*		*Veronica persica*	
A1	B5.1	Observed	Expected	Observed	Expected	Observed	Expected
15	-	10	-	56.7	-	10	-
30	-	50	-	70	-	6.7	-
-	125	100	-	6.7	-	33.3	-
-	250	93.3	-	0	-	26.7	-
15	125	100	100	86.7	59.6	80	40
15	250	100	94.0	86.7	56.7	93.3	34
30	125	100	100	86.7	72.0	46.7	37.8
30	250	100	96.7	93.3	70.0	80.0	31.6

Table 19

Herbicidal performance of compound (A1) and pyrazolate (B5.5) against sulfonylurea herbicide-resistant weeds in the greenhouse (by soil application)

Compound / Dose (g a.i. ha^{-1})		% weed control							
		Resistant *Monochoria vaginalis*		Resistant *Rotala indica*		Resistant *Lindernia procumbens*		Resistant *Cyperus difformis*	
A1	B5.5	Observed	Expected	Observed	Expected	Observed	Expected	Observed	Expected
21	-	31.7	-	16.7	-	50	-	58.3	-
-	1800	90	-	62.5	-	65	-	65	-
21	1800	100	93.2	73.3	68.8	86.7	82.5	100	85.4

Table 20

Herbicidal performance of compound (A1) and butachlor (B6.1) against sulfonylurea herbicide-resistant weeds in the greenhouse (by soil application)

Compound / Dose (g a.i. ha^{-1})		% weed control			
		Resistant *Monochoria vaginalis*		Resistant *Lindernia procumbens*	
A1	B6.1	Observed	Expected	Observed	Expected
21	-	26.7	-	50	-
-	1500	95	-	72.5	-
21	1500	100	96.3	96.7	86.3

Table 21

Herbicidal performance of compound (A1) and benfuresate (B7.1) against perennial weed, *Eleocharis kuroguwai* in the greenhouse (by soil application)

Compound / Dose (g a.i. ha^{-1})		% weed control	
		Eleocharis kuroguwai	
A1	B2.13	Observed	Expected
21	-	30	-
-	360	60	-
-	450	75	-
21	360	80	72
21	450	90	82.5

Table 22

Herbicidal performance of compound (A1) and thiobencarb (B7.5) against sulfonylurea herbicide-resistant weeds in the greenhouse (by soil application)

Compound / Dose (g a.i. ha^{-1})		% weed control					
		Resistant *Monochoria vaginalis*		Resistant *Rotala indica*		Resistant *Lindernia procumbens*	
A1	B7.5	Observed	Expected	Observed	Expected	Observed	Expected
21	-	26.7	-	43.3	-	43.3	-
-	2100	85	-	70	-	90	-
21	2100	100	89	96.7	83	100	94.3

Table 23

Herbicidal performance of compound (A1) and 2,4-D (B8.3) against broad-leaved weeds in the field (by foliar application)

Compound / Dose (g a.i. ha^{-1})		% Weed control							
		Brassica napus		*Galium aparine*		*Papaver rhoeas*		*Veronica persica*	
A1	B8.3	Observed	Expected	Observed	Expected	Observed	Expected	Observed	Expected
15	-	80.0	-	56.7	-	6.7	-	10	-
30	-	93.4	-	70	-	30	-	6.7	-
-	650	60.0	-	0	-	33.3	-	20	-
15	650	100	92	-	-	40	37.8	33.3	28
30	650	100	97.4	86.7	70	73.3	53.3	-	-

Table 24

Herbicidal performance of compound (A1) and clomeprop (B8.7) against sulfonylurea herbicide-resistant weeds in the greenhouse (by soil application)

Compound / Dose (g a.i. ha^{-1})		% Weed control							
		Resistant *Monochoria vaginalis*		Resistant *Rotala indica*		Resistant *Lindernia procumbens*		Resistant *Cyperus difformis*	
A1	B8.7	Observed	Expected	Observed	Expected	Observed	Expected	Observed	Expected
21	-	31.7	-	16.7	-	50	-	58.3	-
-	300	60	-	85	-	72.5	-	70	-
21	300	91.7	72.7	98.3	87.5	100	86.3	90	87.5

Table 25

Herbicidal performance of compound (A1) and dithiopyr (B9.2) against sulfonylurea herbicide-resistant *Monochoria vaginalis* in the greenhouse (by soil application)

Compound / Dose (g a.i. ha^{-1})		% weed control	
		Monochoria vaginalis	
A1	B9.2	Observed	Expected
15	-	0	-
20	-	0	-
30	-	0	-
-	45	70	-
15	45	90	70
20	45	90	70
30	45	90	70

Table 26

Herbicidal performance of compound (A1) and dithiopyr (B9.2) against sulfonylurea herbicide-resistant *Monochoria vaginalis* in the greenhouse (by soil application)

Compound / Dose (g a.i. ha^{-1})	% weed control
	Monochoria vaginalis

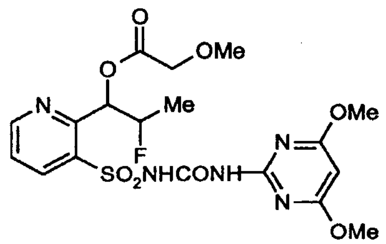
A1	B9.2	Observed	Expected
15	-	0	-
30	-	0	-
-	30	0.3	-
-	45	46.7	-
-	60	78.3	-
-	90	94.7	-
15	30	30.0	0.3
15	45	70.0	46.7
15	60	93.3	78.3
15	90	96.7	94.7
30	30	16.7	0.3
30	45	53.3	46.7
30	60	90.0	78.3
30	90	100.0	94.7

INDUSTRIAL APPLICABILITY

The herbicidal composition of the present invention has increased herbicidal efficacy and extended weed spectrum, and so the amount of used herbicidal ingredients can be reduced due to synergistic effect by mixing two herbicidal compounds having different functions or different herbicidal efficacies, compared to individual application of each herbicidal compound, and so the cost for weed control can be reduced by saving labor through co-application of flucetosulfuron and other herbicidal compounds contained in the herbicidal composition. Furthermore, the herbicidal composition comprising the compound of the formula (1) or (2) and one or more other herbicidal compounds selected from the group consisting of photosynthesis inhibitor bentazone, protopropyrinogen IX oxidase inhibitor carfentrazone-ethyl, and auxin-type herbicides, has synergistic effect to increase herbicidal activity for perennial weeds and sulfonylurea resistant weeds, and can resolve antagonism for grass weeds, particularly barnyardgrass, and can increase the safety on rice for foliar application.

WHAT IS CLAIMED IS

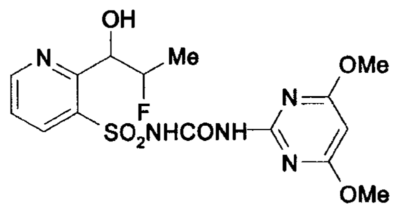
1. A herbicidal composition comprising a compound of the following formula (1) (herbicidal active ingredient (A1));



(1)

and one or more other active ingredients selected from the group (B) consisting of (B1.1) diclofop and ester thereof, (B1.2) metamifop, (B1.3) cyhalofop-butyl, (B1.4) clodinafop-propargyl (B1.5) fenoxaprop-P and ester thereof, (B1.6) flamprop-M and ester thereof, (B1.7) tralcoxydim, (B1.8) profoxydim, (B2.1) thifensulfuron-methyl, (B2.2) metsulfuron-methyl, (B2.3) prosulfuron, (B2.4) tribenuron-methyl, (B2.5) mesosulfuron-methyl, (B2.6) flazasulfuron, (B2.7) sulfosulfuron, (B2.8) iodosulfuron and ester thereof, (B2.9) flupyrsulfuron and ester thereof, (B2.10) bensulfuron and ester thereof, (B2.11) cyclosulfamuron, (B2.12) cinosulfuron, (B2.13) azimsulfuron, (B2.14) imazosulfuron, (B2.15) pyrazosulfuron-ethyl, (B2.16) penoxulam, (B2.17) florasulam, (B2.18) bispyribac-sodium, (B2.19) pyribenzoxim, (B3.1) bentazone, (B3.2) bromoxynil and bromoxynil-octanoate, (B3.3) ioxynil, and ester and salt thereof, (B3.4) terbutryn, (B3.5) simetryn, (B3.6) chlorotoluron (B3.7) isoproturon, (B4.1) oxyfluorfen, (B4.2) pyraflufen-ethyl, (B4.3) carfentrazone-ethyl, (B4.4) cinidon-ethyl, (B4.5) oxadiargyl, (B4.6) pentoxazone, (B5.1) diflurfenican, (B5.2) picolinafen, (B5.3) mesotrione, (B5.4) pyrazoxyfen, (B5.5) pyrazolate, (B5.6) benzobicyclon, (B5.7) clomazone, (B6.1) butachlor, (B6.2) flufenacet, (B6.3) mefenacet, (B6.4) fentrazamide, (B6.5) pretilachlor, (B6.6) cafenstrole, (B6.7) isoxaben, (B7.1) benfuresate, (B7.2) ethofumesate, (B7.3) prosulfocarb, (B7.4) triallate, (B7.5) thiobencarb, (B8.1) triclopyr, (B8.2) fluroxypyr and ester thereof, (B8.3) 2,4-D and ester thereof, (B8.4) MCPA and ester thereof, (B8.5) MCPB and ester thereof, (B8.6) mecoprop and mecoprop-P, (B8.7) clomeprop, (B8.8) dicamba, (B9.1) pendimethalin, (B9.2) dithiopyr, (B9.3) difenzoquat-methyl sulfate, (B9.4) bromobutide, (B9.5) indanofan, and (B9.6) pyributicarb.

2. A herbicidal composition comprising a compound of the following formula (2) (herbicidal active ingredient (A2));



(2)

and one or more other active ingredients selected from the group (B) as defined in claim 1.

3. The herbicidal composition of claim 1 or 2, wherein the weight ratio of the active ingredient A1 or A2 and the active ingredient B is 1:200 to 200:1.

4. The herbicidal composition of claim 3, wherein the weight ratio of the active ingredient A1 or A2 and the active ingredient B is 1:100 to 20:1.

5. The herbicidal composition of claim 1 or 2, further comprising one or more selected from the group consisting of insecticide, fungicide, safener and plant growth regulator.

6. The herbicidal composition of claim 1 or 2, further comprising one or more selected from the group consisting of carriers, surfactants and additives.

7. A method for controlling weed, comprising applying the herbicidal composition of claim 1 or 2 to crop fields or non-cropping area.

8. A method for controlling weed, comprising applying the herbicidal composition of claim 1 or 2 to rice cultivation.

9. A method for controlling weed, comprising applying the herbicidal composition of claim 1 or 2 to cereals cultivation.

10. A method for controlling weed, comprising applying the herbicidal composition of claim 1 or 2 to grass or pasture.

11. The method of claim 7, wherein the herbicidal composition is treated by foliar application.

12. The method of claim 11, wherein the active ingredient B is one or more selected from the group consisting of (B3.1) bentazone, (B4.3) carfentrazone-ethyl, (B8.2) fluroxypyr and ester thereof, (B8.3) 2,4-D and ester thereof, (B8.4) MCPA and ester thereof, (B8.5) MCPB and ester thereof, (B8.6) mecoprop and mecoprop-P, (B8.7) clomeprop and (B8.8) dicamba.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2005/004337

A. CLASSIFICATION OF SUBJECT MATTER

A01N 41/06(2006.01)i, A01P 13/00(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)
IPC8 A01N 43/40, A01N 47/36

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Patents and Applications for Invention since 1975
Korean Utility models and Applications for Utility models since 1975

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search terms used)
KIPASS, PAJ, STN

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KIM, JIN ET AL "Degradation of the sulfonylurea herbicide LGC-42153 in flooded soil" Pest management Science (2003), 59(11), 1260-1264. see the whole document	1 - 12
A	KIM, JIN ET AL " Aerobic soil metabolism of a new herbicide, LGC-42153" Journal of Agricultural and Food Chemistry (2003), 51(3) 710-714. see the whole document	1 - 12
A	KR 2002-029177 A (LG Chem Investment, Ltd.) 18 APRIL 2002 cited in the application see the whole document	1 - 12
A	KR 1994-023894 A (KRICT) 17 NOVEMBER 1994 cited in the application see the whole document	1 - 12

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 MARCH 2006 (20.03.2006)	**21 MARCH 2006 (21.03.2006)**

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