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(54) Titre : COMPOSITION HERBICIDE
(54) Title: HERBICIDAL COMPOSITION

(57) Abrégé/Abstract:
The present invention is directed to a herbicidal composition containing (a) 2-[4-chloro-2-fluoro-5-(n-pentyl-oxycarbonylmethoxy)phenyl]-4,5,6,7-tetrahydro-2H-isoindole-1,3-dione and (b) at least one compound selected from the group consisting of N-(phosphonomethyl)glycine, (2-amino-4-methylphosphinobutyryl)alanylalanine, DL-homoalanin-4-methyl-yl(methyl)phosphinic acid and salts thereof. The invention is also directed to a method for controlling undesired weeds by application of the herbicidal composition.

Abstract

The present invention is directed to a herbicidal composition containing (a) 2-[4-chloro-2-fluoro-5-(n-pentyloxycarbonylmethoxy)phenyl]-4,5,6,7-tetrahydro-2H-isoindole-1,3-dione and (b) at least one compound selected from the group consisting of N-(phosphonomethyl)glycine, (2-amino-4-methylphosphinobutyryl)alanylalanine, DL-homoalanin-4-methyl-yl(methyl)phosphinic acid and salts thereof. The invention is also directed to a method for controlling undesired weeds by application of the herbicidal composition.

HERBICIDAL COMPOSTION

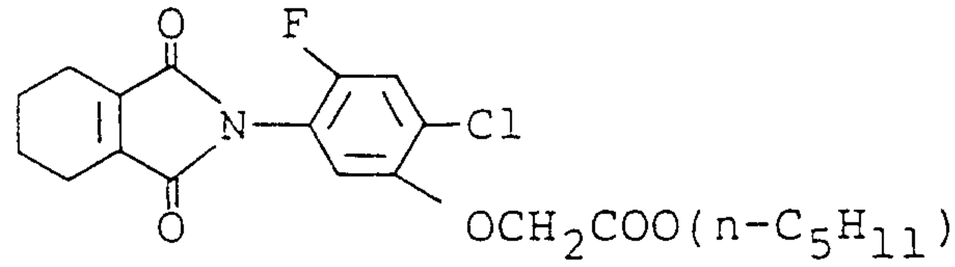
The present invention relates to a herbicidal composition, and more particularly, to a herbicidal compostion which is a combination of particular active ingredients.

In recent years, a number of herbicides have been used to weed agricultural and non-agricultural fields. There are, however, many varieties of weeds to be exterminated or controlled, and it is desirable to develop excellent herbicides having a stronger herbicidal activity against a wide variety of weeds, i.e., having a wider weeding spectrum.

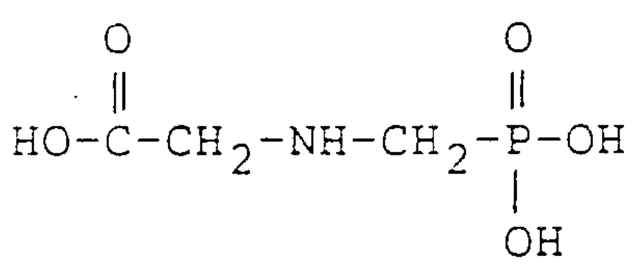
Many of the herbicides are applied to agricultural fields before plowing or planting of crops. In that case, it is desirable to use herbicides that rapidly exert a herbicidal effect so that it is possible to plow or plant crops in these agricultural fields soon after the treatment. Such a herbicide is further required to have no material phytotoxicity against the planted crops after the treatment.

Under these circumstances, the present inventors have intensively studied various herbicidal compounds, and have found that a combination of particular herbicidal compounds as active ingredients is useful for herbicidal compositions having excellent herbicidal activity.

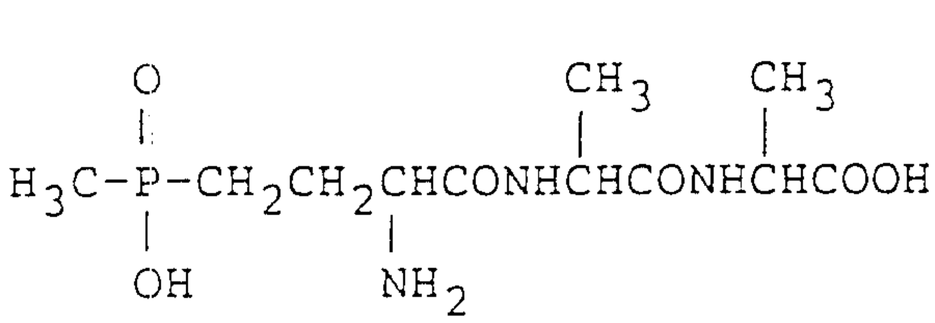
According to the present invention, there is provided a herbicidal composition comprising as active ingredients a herbicidally effective amount of (a) 2-[4-chloro-2-fluoro-5-(n-pentyloxycarbonylmethoxy)phenyl]-4,5,6,7-tetrahydro-2H-isoindole-1,3-dione of the formula:



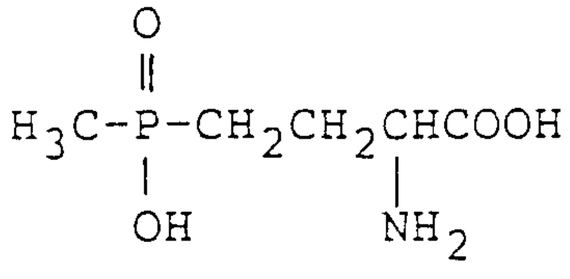
and (b) at least one compound selected from the group consisting of N-(phosphonomethyl)glycine of the formula:



and salts thereof, (2-amino-4-methylphosphinobutyryl)-alanylalanine of the formula:



and salts thereof, DL-homoalanin-4-yl(methyl)phosphinic acid of the formula:



and salts thereof.

The present invention also provides a method for controlling undesired weeds, which comprises applying the above herbicidal composition to the area where the undesired weeds grow.

The herbicidal composition of the present invention is characterized by the combined use of active ingredients (a) and (b). This combined use provides the excellent advantages of exterminating or controlling a wide variety of weeds in agricultural and non-agricultural fields, and of rapidly exerting a herbicidal effect in comparison with the sole use of each of these ingredients. That is, the rapidity of the herbicidal effect is enhanced synergistically, thereby making it possible to apply the composition at a smaller dosage. This is favourable from an economic point of view. Moreover, the herbicidal composition of the present invention has substantially no material phytotoxicity against the planted crops after treatment therewith.

The herbicidal composition of the present invention can exterminate or control a wide variety of weeds, examples of which are broad-leaf weeds, e.g. wild buckwheat

(Polygonum convolvulus), pale smartweed (Polygonum lapathifolium), curly dock (Rumex crispus), common purslane (Portulaca oleracea), common chickweed (Stellaria media), water chickweed (Stellaria aquatica), common lambsquarters (Chenopodium album), redroot pigweed (Amaranthus retroflexus), wild mustard (Sinapis arvensis), shepherdspurse (Capsella bursa-pastoris), hemp sesbania (Sesbania exaltata), sicklepod (Cassia obtusifolia), Japanese hedgeparsley (Torilis japonica), velvetleaf (Abutilon theophrasti), prickly sida (Sida spinosa), field pansy (Viola arvensis), catchweed bedstraw (Galium aparine), ivyleaf morningglory (Ipomoea hederacea), tall morningglory (Ipomoea purpurea), field bindweed (Convolvulus arvensis), red deadnettle (Lamium purpureum), henbit (Lamium amplexicaure), jimsonweed (Datura stramonium), black nightshade (Solanum nigrum), persian speedwell (Veronica persica), common cocklebur (Xanthium pensylvanicum), common sunflower (Helianthus annus), scentless chamomile (Matricaria perforata), corn marigold (Chrysanthemum segetum), Japanese mugwort (Artemisia princeps), tall goldenrod (Solidago altissima) and corn spurry (Spergula arvensis); gramineous weeds, e.g. colorado bluestem (Agropyron tsukushiense), barnyardgrass (Echinochloa crus-galli), green foxtail (Setaria viridis), giant foxtail (Setaria faberi), large crabgrass (Digitaria sanguinalis), annual bluegrass (Poa annua), blackgrass (Alopecurus

myosuroides), oats (Avena sativa), wild oats (Avena fatua), johnsongrass (Sorghum halepense), quackgrass (Agropyron repens), downy brome (Bromus tectorum) and bermudagrass (Cynodon dactylon); commelinaceous weeds, e.g. Asiatic dayflower (Commelina communis); and cyperaceous weeds, e.g. rice flatsedge (Cyperus iria) and purple nutsedge (Cyperus rotundus).

In cases where the herbicidal composition of the present invention is applied to agricultural fields before plowing or planting of crops, it should be noted that the herbicidal composition of the present invention has substantially no phytotoxicity against main crops, for example, soybean (Glycine max), corn (Zea mays), cotton (Gossupium hirsutum), wheat (Triticum aestivum), sugar beet (Beta vulgaris), barley (Hordeum vulgare) and rice (Oryza sativa); and vegetables, e.g. radish (Raphanus sativus), onion (Allium cepa) and carrot (Daucus carota var. sativus).

The active ingredients (a) and (b) are already known in the art; for example, 2-[4-chloro-2-fluoro-5-(n-pentyloxycarbonylmethoxy)phenyl]-4,5,6,7-tetrahydro-2H-isoindole-1,3-dione is disclosed in the specification of United States Patent No. 4,670,046; N-(phosphonomethyl)-glycine and salts thereof (hereinafter referred to as glyphosate) are herbicides described by C. R. Worthing et al., in "The Pesticide Manual", 8th ed., 1987, pp. 449-450; (2-amino-4-methylphosphinobutyryl)alanylalanine and salts

thereof (hereinafter referred to as bialaphos) are herbicides described by Tetsuo Takematsu, in "Josoh-zai Kenkyu Sohran (General Survey of Herbicide Research)", 1982, p. 611; and DL-homoalanin-4-yl(methyl)phosphinic acid and salts thereof (hereinafter referred to as glufosinate) are herbicides described by C. R. Worthing et al., in "The Pesticide Manual", 8th ed., 1987, p. 448.

Examples of the salts of N-(phosphonomethyl)glycine are pesticidally acceptable salts, e.g. isopropylamine salts, ammonium salts and trimethylsulfonium salts. Examples of the salts of (2-amino-4-methylphosphinobutyryl)-alanylalanine are pesticidally acceptable salts, e.g. sodium salts. Examples of the salts of DL-homoalanin-4-yl(methyl)phosphinic acid are pesticidally acceptable salts , e.g ammonium salts.

The weight ratio of ingredients (a) to (b) is usually 1 : 0.25 to 100, preferably 1 : 0.5 to 70, although it may vary over a considerably wide range.

For practical use of the herbicidal composition of the present invention, it is usually formulated by independently mixing each of the active ingredients with conventional solid or liquid carriers, surfactants and other adjuvants to form conventional formulations such as wettable powders, flowable compositions, water-dispersible granules, emulsifiable concentrates, solutions, water-soluble powders and water-soluble granules, followed

by blending these formulations at appropriate ratios; or formulated by mixing all of the active indredients at once with conventional solid or liquid carriers, surfactants and other adjuvants to form conventional formulations such as wettable powders, flowable compositions and water-dispersible granules.

These formulations contain the active ingredients (a) and (b) in a total content of from 1% to 90% by weight, preferably from 2% to 80% by weight.

Examples of the solid carrier are fine powders or granules of kaolin clay, attapulgite clay, bentonite, terra alba, pyrophyllite, talc, diatomaceous earth, calcite, walnut shell powders, urea, ammonium sulfate and synthetic hydrated silica. As the liquid carrier, the following can be used: aromatic hydrocarbons, e.g. xylene and methylnaphthalene; alcohols, e.g. isopropanol, ethylene glycol and cellosolve; ketones, e.g. acetone, cyclohexanone and isophorone; vegetable oils, e.g. soybean oil and cotton seed oil; dimethylsulfoxide, N,N-dimethylformamide, acetonitrile, water or the like.

Examples of the surfactant used for emulsification, dispersing or spreading are those of the anionic type, for example, alkylsulfates, alkylsulfonates, alkylarylsulfonates, dialkylsulfosuccinates (salts or esters) and phosphates of polyoxyethylene alkylaryl ethers; and those of the nonionic type, for example, polyoxyethylene alkyl ethers, polyoxyethylene alkylaryl ethers, polyoxyethylene polyoxypropylene block

copolymers, sorbitan fatty acid esters and polyoxyethylene sorbitan fatty acid esters.

Examples of the auxiliary agent are ligninsulfonates, alginates, polyvinyl alcohol, gum arabic, carboxymethyl cellulose (CMC) and isopropyl acid phosphate (PAP).

The herbicidal composition of the present invention can be used as a herbicide to be employed for upland fields, non-cropping fields, levees of paddy fields, orchards, pasturelands, lawns, forests or non-agricultural fields. The herbicidal composition of the present invention is used for post-emergence control of undesired weeds by foliar treatment.

The dosage of the herbicidal composition of the present invention may vary depending upon the mixing ratio of the active ingredients, formulation type employed, species of undesired weeds to be controlled, prevailing weather conditions and the like. Usually, however, the total amount of the active ingredients to be applied is from 100 to 5000 grams, preferably from 200 to 3000 grams per hectare. The herbicidal composition formulated in any suitable formulation is usually employed by diluting it with water at a volume of from about 100 to 1000 liters per hectare, if necessary, with the addition of an adjuvant, e.g. a spreading agent. Examples of the adjuvant are, in addition to the surfactants as described above, polyoxy-

ethylene resin acids (esters), ligninsulfonates, abietates, dinaphthylmethanedisulfonates, petroleum oil, crop oil concentrate and crop oil , e.g. soybean oil, corn oil, cotton seed oil and sunflower oil.

Further, the herbicidal composition of the present invention may be used together with any other herbicide to enhance its herbicidal activity, and in some cases, synergistic effects can be expected. Moreover, it may also be used in admixture with insecticides, acaricides, nematocides, fungicides, plant growth regulators, fertilizers and the like.

The present invention will be explained in more detail by way of the following Formulation Examples and Test Examples, which are not to be construed to limit the scope thereof.

In the following Formulation Examples for the active ingredient (a), all parts are by weight.

Formulation Example 1

Eighty parts of ingredient (a), 5 parts of polyoxyethylene alkylaryl ether and 15 parts of synthetic hydrated silica were well mixed while being powdered to obtain a wettable powder.

Formulation Example 2

Ten parts of ingredient (a), 7 parts of polyoxyethylene alkylaryl ether, 3 parts of alkylarylsulfonate and 80 parts of cyclohexanone were well mixed to obtain an

emulsifiable concentrate.

Formulation Example 3

Twenty parts of ingredient (a) were mixed with 60 parts of water containing 3% by weight of polyoxyethylene sorbitan monooleate, and the mixture was pulverized until the particle size was less than 3 microns, after which 20 parts of an aqueous solution containing 3% by weight of sodium alginate were added to obtain a flowable composition.

The practical herbicidal activity and phytotoxicity of the herbicidal composition of the present invention will be described with reference to the following Test Examples, wherein they are shown by a rating of from 0 (no influence) to 10 (complete dying). The glyphosate, bialaphos and glufosinate used in these Test Examples refer to the commercially available herbicide "Roundup®" (containing 41% by weight of glyphosate as an isopropylamine salt), commercially available herbicide "Herbiace®" (aqueous solution containing 20% by weight of bialaphos as a sodium salt) and commercially available herbicide "Basta®" (liquid formulation containing 18.5% by weight of glufosinate as an ammonium salt), respectively.

Test Example 1

Plastic vats (area, 17 x 25 cm^2; depth, 7 cm) were filled with upland field soil, and the seeds of corn spurry (Spergula arvensis) as a test plant were sown therein, followed by cultivation of the test plant in a greenhouse

for 20 days. The active ingredient (a) formulated in an emulsifiable concentrate as in Formulation Example 2 and glyphosate as the active ingredient (b) at the designated amounts were diluted with water. The dilution was uniformly sprayed over the foliage of the test plant by means of a small sprayer at a spray volume of 1000 liters per hectare. At that time, the test plant was from 6 to 8 cm in height. Thereafter, the test plant was further grown in the greenhouse for 3 days, and the herbicidal activity was examined. The results are shown in Table 1.

Table 1

Active ingredient	Dosage (g/ha)	Herbicidal activity
(a) only	10	3.0
	100	3.9
(b) only	600	1.2
	2000	1.9
(a) + (b)	10 + 600	8.0
	100 + 2000	8.9

Test Example 2

Plastic vats (area, 17 × 25 cm^2; depth, 7 cm) were filled with upland field soil, and the seeds of common purslane (Portulaca oleracea) as a test plant were sown therein, followed by cultivation of the test plant in a greenhouse for 27 days. The active ingredient (a) formulated in a wettable powder as in Formulation Example 1 and glyphosate as the active ingredient (b) in the

designated amounts were diluted with water containing a 0.2% (v/v) spreading agent (containing an 80% polyoxyethylene dodecyl ether type surfactant). The dilution was uniformly sprayed over the foliage of the test plant by means of a small sprayer at a spray volume of 1000 liters per hectare. At that time, the test plant was from 25 to 30 cm in height. Thereafter, the test plant was further grown in the greenhouse for 29 days. The herbicidal activity was examined 3 days and 29 days after treatment. The results are shown in Table 2.

Table 2

Active ingredient	Dosage (g/ha)	Herbicidal activity	
		3 DAT*	29 DAT*
(a) only	50	6.5	9.0
	100	8.0	9.5
	200	9.0	10.0
(b) only	600	0.5	7.0
	1200	0.5	9.5
(a) + (b)	50 + 600	8.0	10.0
	50 + 1200	9.5	10.0
	100 + 600	9.0	10.0
	100 + 1200	9.5	10.0
	200 + 600	10.0	10.0
	200 + 1200	10.0	10.0

* DAT: Days after treatment

Test Example 3

Plastic vats (area, 17 × 25 cm^2; depth, 7 cm) were filled with upland field soil, and the seeds of large crabgrass (Digitaria sanguinalis as a test plant were sown

therein, followed by cultivation of the test plant in a greenhouse for 27 days. The active ingredient (a) formulated in a wettable powder as in Formulation Example 1 and glyphosate as the active ingredient (b) in the designated amounts were diluted with water containing a 0.2% (v/v) spreading agent (containing an 80% polyoxyethylene dodecyl ether type surfactant). The dilution was uniformly sprayed over the foliage of the test plant by means of a small sprayer at a spray volume of 1000 liters per hectare. At that time, the test plant was from 15 to 20 cm in height. Thereafter, the test plant was further grown in the greenhouse for 29 days. The herbicidal activity was examined 3 days and 29 days after treatment. The results are shown in Table 3.

Table 3

Active ingredient	Dosage (g/ha)	Herbicidal activity	
		3 DAT	29 DAT
(a) only	50	2.0	2.5
	100	3.0	4.0
	200	3.5	5.0
(b) only	800	2.5	9.0
	1200	3.0	9.5
(a) + (b)	50 + 800	8.0	10.0
	50 + 1200	8.5	10.0
	100 + 800	8.5	10.0
	100 + 1200	9.0	10.0
	200 + 800	8.5	10.0
	200 + 1200	9.0	10.0

Test Example 4

Plastic vats (area, 17 × 25 cm^2; depth, 7 cm) were filled with upland field soil, and the seeds of large crabgrass (Digitaria sanguinalis) as a test plant were sown therein, followed by cultivation of the test plant in a greenhouse for 27 days. The active ingredient (a) formulated in a wettable powder as in Formulation Example 1 and glufosinate as the active ingredient (b) in the designated amounts were diluted with water containing a 0.2% (v/v) spreading agent (containing an 80% polyoxyethylene dodecyl ether type surfactant). The dilution was uniformly sprayed over the foliage of the test plant by mean of a small sprayer at a spray volume of 1000 liters per hectare. At that time, the test plant was from 15 to 20 cm in height. Thereafter, the test plant was further grown in the greenhouse for 28 days. The herbicidal activity was examined 2 days and 28 days after treatment. The results are shown in Table 4.

Table 4

Active ingredient	Dosage (g/ha)	Herbicidal activity	
		2 DAT	28 DAT
(a) only	50	2.0	2.5
	100	2.5	4.0
	200	3.5	5.0
(b) only	500	4.0	9.5
	650	4.5	10.0
	800	5.0	10.0
(a) + (b)	50 + 500	8.0	10.0
	50 + 650	8.5	10.0
	50 + 800	9.0	10.0
	100 + 500	8.5	10.0
	100 + 650	8.5	10.0
	100 + 800	9.0	10.0
	200 + 500	9.0	10.0
	200 + 650	9.0	10.0
	200 + 800	9.5	10.0

Test Example 5

Plastic vats (area, 17 × 25 cm^2; depth, 7 cm) were filled with upland field soil, and the seeds of giant foxtail (Setaria faberi) as a test plant were sown therein, followed by cultivation of the test plant outdoors for 25 days. The active ingredient (a) formulated in a wettable powder as in Formulation Example 1 and bialaphos as the active ingredient (b) in the designated amounts were diluted with water containing a 0.2% (v/v) spreading agent (containing an 80% polyoxyethylene dodecyl ether type surfactant). The dilution was uniformly sprayed over the foliage of the test plant by means of a small sprayer at a

spray volume of 1000 liters per hectare. At that time, the test plant was from 20 to 25 cm in height. Thereafter, the test plant was further grown outdoors for 35 days. The herbicidal activity was examined 4 days and 35 days after treatment. The results are shown in Table 5.

Table 5

Active ingredient	Dosage (g/ha)	Herbicidal activity	
		4 DAT	35 DAT
(a) only	50	1.0	1.5
	200	2.5	3.0
(b) only	600	5.5	6.5
	1200	6.5	10.0
(a) + (b)	50 + 600	7.5	10.0
	50 + 1200	8.5	10.0
	200 + 600	9.0	10.0
	200 + 1200	9.5	10.0

Test Example 6

Plastic vats (area, 17 × 25 cm^2; depth, 7 cm) were filled with upland field soil. The active ingredient (a) formulated in a wettable powder as in Formulation Example 1 and glyphosate, bialaphos or glufosinate as the active ingredient (b) in the designated amounts were diluted with water containing a 0.2% (v/v) spreading agent (containing an 80% polyoxyethylene dodecyl ether type surfactant). The dilution was uniformly sprayed on the soil surface by means of a small sprayer at a spray volume of 1000 liters per hectare. After 6 days, the surface soil about 2 cm in depth

was uniformly mixed, and the seeds of radish (Raphanus sativus), onion (Allium cepa) and carrot (Daucus carota var. sativus) as test plants were sown therein at a depth of 1 cm. Thereafter, the test plants were cultivated in a greenhouse for 33 days, and the phytotoxicity against the respective test plants was examined. The results are shown in Table 6.

Table 6

Active ingredient	Dosage (g/ha)	Phytotoxicity		
		Radish	Onion	Carrot
(a) + Glyphosate	400 + 1200	0	0	0
(a) + Glufosinate	400 + 800	0	0	0
(a) + Bialaphos	400 + 1200	0	0	0

Claims:

1. A herbicidal composition comprising of (a) 2-[4-chloro-2-fluoro-5-(n-pentyloxycarbonylmethoxy)phenyl]-4,5,6,7-tetrahydro-2H-isoindole-1,3-dione and (b) at least one compound selected from the group consisting of N-(phosphono-methyl)glycine, (2-amino-4-methylphosphinobutyryl)alanyl-alanine, DL-homoalanin-4-yl(methyl)phosphinic acid and salts thereof.

2. A composition according to claim 1, wherein the weight ratio of ingredients (a) to (b) is 1 : 0.25 to 100.

3. A composition according to claim 1, wherein the weight ratio of ingredients (a) to (b) is 1 : 0.5 to 70.

4. A composition according to claim 1, wherein said ingredient (b) is selected from N-(phosphonomethyl)-glycine and salts thereof.

5. A composition according to claim 4, wherein the weight ratio of ingredients (a) to (b) is 1 : 0.25 to 100.

6. A composition according to claim 4, wherein the weight ratio of ingredients (a) to (b) is 1 : 0.5 to 70.

7. A composition according to claim 1, wherein said ingredient (b) is selected from (2-amino-4-methyl-phosphinobutyryl)alanylalanine and salts thereof.

8. A composition according to claim 7, wherein the weight ratio of ingredients (a) to (b) is 1 : 0.25 to 100.

9. A composition according to claim 7, wherein the weight ratio of ingredients (a) to (b) is 1 : 0.5 to 70.

10. A composition according to claim 1, wherein said ingredient (b) is selected from DL-homoalanin-4-yl-(methyl)phosphinic acid and salts thereof.

11. A composition according to claim 10, wherein the weight ratio of ingredients (a) to (b) is 1 : 0.25 to 100.

12. A composition according to claim 10, wherein the weight ratio of ingredients (a) to (b) is 1 : 0.5 to 70.

13. A method for controlling undesired weeds, which comprises applying a herbicidally effective amount of the herbicidal composition according to claim 1 to the area where the undesired weeds grow.

14. A method according to claim 13, wherein the total amount of ingredients (a) and (b) in the composition is from 100 to 5000 grams per hectare.

15. A method according to claim 13, wherein the total amount of ingredients (a) and (b) in the composition is from 200 to 3000 grams per hectare.

16. A method according to claim 13, wherein said ingredient (b) is selected from N-(phosphonomethyl)glycine and salts thereof.

17 A method according to claim 16, wherein the total amount of ingredients (a) and (b) in the composition is from 100 to 5000 grams per hectare.

18. A method according to claim 16, wherein the total amount of ingredients (a) and (b) in the composition is from 200 to 3000 grams per hectare.

19. A method according to claim 13, wherein said ingredient (b) is selected from (2-amino-4-methylphosphino-butyryl)alanylalanine and salts thereof.

20. A method according to claim 19, wherein the total amount of ingredients (a) and (b) in the composition is from 100 to 5000 grams per hectare.

21. A method according to claim 19, wherein the total amount of ingredients (a) and (b) in the composition is from 200 to 3000 grams per hectare.

22. A method according to claim 13, wherein said ingredient (b) is selected from DL-homoalanin-4-yl(methyl)-phosphinic acid and salts thereof.

23. A method according to claim 22, wherein the total amount of ingredients (a) and (b) in the composition is from 100 to 5000 grams per hectare.

24. A method according to claim 22, wherein the total amount of ingredients (a) and (b) in the composition is from 200 to 3000 grams per hectare.