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(71) Applicant:  DOW AGROSCIENCES LLC [US/US]; 9330 Zionsville Road, Indianapolis, IN 46268 (US).
(72) Inventors:  SATCHIVI, Norbert, M.; 3100 Cherub Court, Carmel, IN 46074 (US). WEIMER, Monte, R.; 9539 Gladstone Drive, Pittsboro, IN 46167 (US).
(74) Agent:  ASAM, Michael; Dow AgroSciences LLC, 9330 Zionsville Road, Indianapolis, Indiana 46268 (US).
Background

[0001] The protection of crops from weeds and other vegetation which inhibit crop growth is a constantly recurring problem in agriculture. To help combat this problem, researchers in the field of synthetic chemistry have produced an extensive variety of chemicals and chemical formulations effective in the control of such unwanted growth. Chemical herbicides of many types have been disclosed in the literature and a large number are in commercial use. However, there remains a need for compositions and methods that are effective in controlling undesirable vegetation.

Summary

[0002] Provided herein are herbicidal compositions comprising a herbicidally effective amount of (a) a compound of the formula (I)

![Chemical Structure](image)

(I)

or an agriculturally acceptable salt or ester thereof, and (b) propyzamide. The compositions may also contain an agriculturally acceptable adjuvant or carrier.

[0003] Also provided are methods of controlling undesirable vegetation comprising applying (a) a compound of formula (I) or an agriculturally acceptable ester or salt thereof and (b) propyzamide.

Detailed Description

DEFINITIONS

[0004] As used herein, the compound of formula (I) has the following structure:
The compound of formula (I) can be identified by the name 4-amino-3-chloro-6-(4-chloro-2-fluoro-3-methoxyphenyl)-pyridine-2-carboxylic acid and has been described in U.S. Patent 7,314,849 (B2), which is incorporated herein by reference in its entirety. Exemplary uses of the compound of the formula (I) include controlling undesirable vegetation, including e.g., grass, broadleaf and sedge weeds, in multiple non-crop and cropping situations.


As used herein, control of or controlling undesirable vegetation means killing or preventing the vegetation, or causing some other adverse modifying effect to the vegetation e.g., deviations from natural growth or development, regulation, desiccation, retardation, and the like.

As used herein, herbicide and herbicidal active ingredient mean a compound that controls undesirable vegetation when applied in an appropriate amount.

As used herein, a herbicidally effective or vegetation controlling amount is an amount of herbicidal active ingredient the application of which controls the relevant undesirable vegetation.

As used herein, applying or application of a herbicide or herbicidal composition means delivering it directly to the targeted vegetation or to the locus thereof or to the area where control of undesired vegetation is desired. Methods of application include, but are not
limited to pre-emergence, post-emergence, foliar, soil, and in-water applications. Described herein are methods of controlling undesirable vegetation through the application of certain herbicide combinations or compositions.

[0011] As used herein, plants and vegetation include, but are not limited to, dormant seeds, germinant seeds, emerging seedlings, plants emerging from vegetative propagules, immature vegetation, and established vegetation.

[0012] As used herein, agriculturally acceptable salts and esters refer to salts and esters that exhibit herbicidal activity, or that are or can be converted in plants, water, or soil to the referenced herbicide. Exemplary agriculturally acceptable esters are those that are or can by hydrolyzed, oxidized, metabolized, or otherwise converted, e.g., in plants, water, or soil, to the corresponding carboxylic acid which, depending on the pH, may be in the dissociated or undissociated form.

[0013] Exemplary salts include those derived from alkali or alkaline earth metals and those derived from ammonia and amines. Exemplary cations include sodium, potassium, magnesium, triethylammonium (TEA) and cations of the formula:

\[ R^1R^2R^3R^4N^+ \]

[0014] wherein \( R^1, R^2, R^3 \) and \( R^4 \) each, independently represents hydrogen or \( \text{C}_3\text{C}_{12} \) alkyl, \( \text{C}_3\text{C}_{12} \) alkynyl or \( \text{C}_3\text{C}_{12} \) alkynyl, each of which is optionally substituted by one or more hydroxy, \( \text{C}_1\text{C}_4 \) alkoxy, \( \text{C}_1\text{C}_4 \) alkylthio or phenyl groups, provided that \( R^1, R^2, R^3 \) and \( R^4 \) are sterically compatible. Additionally, any two of \( R^1, R^2, R^3 \) and \( R^4 \) together may represent an aliphatic difunctional moiety containing one to twelve carbon atoms and up to two oxygen or sulfur atoms. Salts can be prepared by treatment with a metal hydroxide, such as sodium hydroxide, with an amine, such as ammonia, trimethylamine, diethanolamine, 2-methylthiopropylamine, bisallylamine, 2-butoxyethylamine, morpholine, cyclododecylamine, or benzylamine or with a tetraalkylammonium hydroxide, such as tetramethylammonium hydroxide or choline hydroxide.

[0015] Exemplary esters include those derived from \( \text{C}_1\text{C}_{12} \) alkyl, \( \text{C}_3\text{C}_{12} \) alkenyl, \( \text{C}_3\text{C}_{12} \) alkynyl or \( \text{C}_7\text{C}_{12} \) aryl-substituted alkyl alcohols, such as methyl alcohol, isopropyl alcohol, 1-butanol, 2-ethylhexanol, butoxyethanol, methoxypropanol, allyl alcohol, propargyl alcohol, cyclohexanol or unsubstituted or substituted benzyl alcohols. Benzyl alcohols may be substituted with from 1-3 substituents independently selected from halogen, \( \text{C}_1\text{C}_4 \) alkyl or
C<sub>1</sub>-C<sub>4</sub> alkoxy. Esters can be prepared by coupling of the acids with the alcohol using any number of suitable activating agents such as those used for peptide couplings such as dicyclohexylcarbodiimide (DCC) or carbonyl diimidazole (CDI); by reacting the acids with alkylating agents such as alkylhalides or alkylsulfonates in the presence of a base such as triethylamine or lithium carbonate; by reacting the corresponding acid chloride of an acid with an appropriate alcohol; by reacting the corresponding acid with an appropriate alcohol in the presence of an acid catalyst or by transesterification.

[0016] As used herein in expressing weight ratios, in cases where a salt or ester of the compound of formula (I) is used, the weight referred to for the salt or ester is the acid equivalent weight.

COMPOSITIONS AND METHODS

[0017] Provided herein are herbicidal compositions comprising a herbicidally effective amount of (a) a compound of the formula (I)

![Chemical Structure](image)

or an agriculturally acceptable salt or ester thereof, and (b) propyzamide.

[0018] Also provided are methods of controlling undesirable vegetation comprising applying a herbicidally effective amount of the compound of formula (I) or an agriculturally acceptable salt or ester thereof and (b) propyzamide. In certain embodiments, the methods employ the compositions described herein.

[0019] Furthermore, in some embodiments, the combination of compound (I) or agriculturally acceptable salt or ester thereof and propyzamide exhibits synergism, e.g., the herbicidal active ingredients are more effective in combination than when applied individually. Synergism has been defined as "an interaction of two or more factors such that the effect when combined is greater than the predicted effect based on the response of each factor applied separately." Senseman, S., Ed. Herbicide Handbook. 9th ed. Lawrence: Weed

[0020] In certain embodiments of the compositions and methods described herein, the compound of formula (I), *i.e.*, the carboxylic acid, is employed. In certain embodiments, a carboxylate salt of the compound of formula (I) is employed, such as the triethylammonium (TEA) or potassium salt. In certain embodiments, a CrC₄ alkyl, *e.g.*, methyl, ester is employed. In certain embodiments, a CrC₁₀ aryl-substituted alkyl, *e.g.*, benzyl, ester is employed.

[0021] In some embodiments, the compound of formula (I) or salt or ester thereof and propyzamide are formulated in one composition, tank-mixed, applied simultaneously, or applied sequentially.

[0022] Herbicidal activity is exhibited by the compositions when they are applied, *i.e.*, delivered directly to the plant or to the locus of the plant at any stage of growth, or to the area where control is desired. The effect observed depends upon the plant species to be controlled, the stage of growth of the plant, the application parameters of dilution and spray drop size, the particle size of solid components, the environmental conditions at the time of use, the specific compound employed, the specific adjuvants and carriers employed, the soil type, and the like, as well as the amount of chemical applied. These and other factors can be adjusted to promote non-selective or selective herbicidal action. In some embodiments, the compositions described herein are applied as a post-emergence application, pre-emergence application, or in-water application to flooded paddy rice or water bodies (*e.g.*, ponds, lakes and streams), to relatively immature undesirable vegetation to achieve the maximum control of weeds.

[0023] In some embodiments, the compositions and methods provided herein are utilized to control weeds in crops, including but not limited to winter/spring oilseed rape, winter/spring canola, vegetables, *Brassica* spp, ornamentals, rice, wheat, triticale, barley, oats, rye, sorghum, corn/maize, sunflower, row crops, pastures, grasslands, rangelands, fallowland, sugarcane, turf, tree and vine orchards, industrial vegetation management (IVM) and rights-of-way.

[0024] The compositions and methods described herein be used to control undesirable vegetation in glyphosate-tolerant-, glufosinate-tolerant-, dicamba-tolerant-, phenoxy auxin-
tolerant-, pyridyloxy auxin-tolerant-, aryloxyphenoxypropionate-tolerant-, acetyl CoA carboxylase (ACCase) inhibitor-tolerant-, imidazolinone-tolerant-, acetolactate synthase (ALS) inhibitor-tolerant-, 4-hydroxyphenyl-pyruvate dioxygenase (HPPD) inhibitor-tolerant-, protoporphyrinogen oxidase (PPO) inhibitor-tolerant-, triazine-tolerant- and bromoxynil-tolerant-crops (such as, but not limited to, soybean, cotton, canola/oilseed rape, sunflower, rice, cereals, corn, turf, tree and vine, sugarcane, etc), for example, in conjunction with glyphosate, glufosinate, dicamba, phenoxy auxins, pyridyloxy auxins, aryloxyphenoxypropionates, ACCase inhibitors, imidazolinones, ALS inhibitors, HPPD inhibitors, PPO inhibitors, triazines, and bromoxynil The compositions and methods may be used in controlling undesirable vegetation in crops possessing multiple or stacked traits conferring tolerance to multiple chemistries and/or inhibitors of multiple modes-of-action. In some embodiments, the compound of formula (I) or salt or ester thereof and complementary herbicide or salt or ester thereof are used in combination with herbicides that are selective for the crop being treated and which complement the spectrum of weeds controlled by these compounds at the application rate employed. In some embodiments, the compositions described herein and other complementary herbicides are applied at the same time, either as a combination formulation or as a tank mix.

[0025] The compositions and methods provided herein are utilized to control undesirable vegetation. Undesirable vegetation includes, but is not limited to, undesirable vegetation that occurs in oilseed rape, canola, vegetables, Brassica spp, ornamentals, rice, wheat, triticale, barley, oats, rye, sorghum, corn/maize, sunflower, row crops, pastures, grasslands, rangelands, fallowland, sugarcane, turf, tree and vine orchards, industrial vegetation management (IVM) and rights-of-way.

[0026] In certain embodiments, the methods and compositions utilizing the compound of formula (I) or salt or ester thereof in combination with propyzamide are used to provide synergistic control of GLXMA, IPOHE, ABUTH, POLCO, SETFA, BRSNW, AMARE, EPHHL, CHEAL, STEME, VIOTR, CIRRAR, GERSS, POAAN, or VERSS.

[0027] In some embodiments, the methods provided herein are utilized to control undesirable vegetation in oilseed rape, canola, drilled crops and cereal crops. In certain embodiments, the undesirable vegetation is Alopecurus myosuroides Huds. (blackgrass, ALOMY), Apera spica-venti (L.) Beauv. (windgrass, APESV), Avenafatua (L.) (wild oat, AVEFA), Bromus tectorum L. (downy brome, BROTE), Lolium multiflorum Lam. (Italian ryegrass, LOLMU), Lolium
rigidum (rigid ryegrass, LOLRI), Lolium multiflorum subsp. Gaudini (annual ryegrass, LOLMG), Phalaris minor Retz. (littleseed canarygrass, PHAMI), Poa annua L. (annual bluegrass, POAAN), Setaria pumila (Poir.) Roemer & J.A. Schultes (yellow foxtail, SETLU), Setaria viridis (L.) Beauv. (green foxtail, SETVI), Cirsium arvense (L.) Scop. (Canada thistle, CIRAR), Galium aparine L. (catchweed bedstraw, GALAP), Kochia scoparia (L.) Schrad. (kochia, KCHSC), Lamium purpureum L. (purple deadnettle, LAMPU), Matricaria recutita L. (wild chamomile, MATCH), Matricaria matricarioides (Less.) Porter (pineappleweed, MATMT), Papaver rhoes L. (common poppy, PAPRH), Polygonum convolvulus L. (wild buckwheat, POLCO), Salsola tragus L. (Russian thistle, SASKR), Stellaria media (L.) Vill. (common chickweed, STEME), Veronica persica Poir. (Persian speedwell, VERPE), Viola arvensis Murr. (field violet, VIOAR), or Viola tricolor L. (wild violet, VIOTR).

[0028] In some embodiments, the methods provided herein are utilized to control undesirable vegetation in rice. In certain embodiments, the undesirable vegetation is Bracharia platyphylla (Groseb.) Nash (broadleaf signalgrass, BRAPP), Digitaria sanguinalis (L.) Scop. (large crabgrass, DIGSA), Echinochloa crus-galli (L.) P. Beauv. (barnyardgrass, ECHCG), Echinochloa colonum (L.) LINK (junglerice, ECHCO), Echinochloa oryzoides (Ard.) Fritsch (early watergrass, ECHOR), Echinochloa oryzicola (Vasinger) Vasinger (late watergrass, ECHPH), Ischaemum rugosum Salisb. (saramollagrass, ISCRU), Leptochloa chinensis (L.) Nees (Chinese sprangletop, LEFFA), Leptochloa fascicularis (Lam.) Gray (bearded sprangletop, LEFFA), Leptochloa panicoides (Presl.) Hitchc. (Amazon sprangletop, LEFPA), Panicum dichotomiflorum (L.) Michx. (Fall panicum, PANDI), Paspalum dilatatum Poir. (dallisgrass, PASDI), Cyperus difformis L. (smallflower flatsedge, CYPD1), Cyperus esculentus L. (yellow nutsedge, CYPES), Cyperus iria L. (rice flatsedge, CYPIR), Cyperus rotundus L. (purple nutsedge, CYPRO), Eleocharis species (ELOSS), Fimbristylis miliacea (L.) Vahl (globe fringerush, FIMMI), Schoenoplectus juncoides Roxb. (Japanese bulrush, SPCJU), Schoenoplectus maritimus L. (sea clubrush, SCPMA), Schoenoplectus mucronatus L. (ricefield bulrush, SCPMU), Aeschynomene species, (jointvetch, AESSS), Alternanthera philoxeroides (Mar.) Griseb. (alligatorweed, ALRPH), Alisma plantago-aquatica L. (common waterplantain, ALSPA), Amaranthus species, (pigweeds and amaranths, AMASS), Ammannia coccinea Rottb. (redstem, AMMCO), Eclipta alba (L.) Hassk. (American false daisy, ECLAL), Heteranthera limosa (SW.) Willd./Vahl (ducksalad, HETL), Heteranthera reniformis R. & P. (roundleaf mudplantain, HETRE), Ipomoea hederacea (L.) Jacq. (ivyleaf
morningglory, IPOHE), Lindernia dubia (L.) Pennell (low false pimpernel, LIDDU), Monochoria korsakowii Regel & Maack (monochoria, MOOKA), Monochoria vaginalis (Burm. F.) C. Presl ex Kuhth, (monochoria, MOOVA), Murdannia nudiflora (L.) Brenan (doveweed, MUDNU), Polygonum pensylvanicum L., (Pennsylvania smartweed, POLPY), Polygonum persicaria L. (ladythumb, POLPE), Polygonum hydropiperoides Michx. (mild smartweed, POLHP), Rotula indica (Willd.) Koehne (Indian toothcup, ROTIN), Sagittaria species, (arrowhead, SAGSS), Sesbania exaltata (Raf.) Cory/Rydb. Ex Hill (hemp sesbania, SEBEX), or Sphenoclea zeylanica Gaertn. (gooseweed, SPDZE).

[0029] In some embodiments, the methods provided herein are utilized to control undesirable vegetation in range and pasture. In certain embodiments, the undesirable vegetation is Ambrosia artemisifolia L. (common ragweed, AMBEL), Cassia obtusifolia (sickle pod, CASOB), Centaurea maculosa auct. non Lam. (spotted knapweed, CENMA), Cirsium arvense (L.) Scop. (Canada thistle, CIRAR), Convolvulus arvensis L. (field bindweed, CONAR), Euphorbia esula L. (leafy spurge, EPHES), Lactuca serriola L./Torn. (prickly lettuce, LACSE), Plantago lanceolata L. (buckhorn plantain, PLALA), Rumex obtusifolius L. (broadleaf dock, RUMOB), Sida spinosa L. (prickly sida, SIDSP), Sinapis arvensis L. (wild mustard, SINAR), Sonchus arvensis L. (perennial sowthistle, SONAR), Solidago species (goldenrod, SOOSS), Taraxacum officinale G.H. Weber ex Wiggers (dandelion, TAROF), Trifolium repens L. (white clover, TRFRE), or Urtica dioica L. (common nettle, URTDI).

[0030] In some embodiments, the methods provided herein are utilized to control undesirable vegetation found in row crops and vegetable crops. In certain embodiments, the undesirable vegetation is Alopecurus myosuroides Huds. (blackgrass, ALOMY), Avenafatua L. (wild oat, AVEFA), Bracharia platyphylla (Groseb.) Nash (broadleaf signalgrass, BRAPP), Digitaria sanguinalis (L.) Scop. (large crabgrass, DIGSA), Echinochloa crus-galli (L.) P. Beauv. (barnyardgrass, ECHCG), Echinochloa colonum (L.) Link (junglerice, ECHCO), Lolium multiflorum Lam. (Italian ryegrass, LOLMU), Panicum dichotomiflorum Michx. (Fall panicum, PANDI), Panicum miliaceum L. (wild-proso millet, PANMI), Setaria faberii Herrm. (giant foxtail, SETFA), Setaria viridis (L.) Beauv. (green foxtail, SETVI), Sorghum halepense (L.) Pers. (Johnsongrass, SORHA), Sorghum bicolor (L.) Moench ssp. Arundinaceum (shattercane, SORVU), Cyperus esculentus L. (yellow natsedge, CYPES), Cyperus rotundus L. (purple natsedge, CYPRO), Abutilon theophrasti Medik. (velvetleaf, ABUTH), Amaranthus species (pigweeds and amaranths, AMASS), Ambrosia artemisifolia

[0031] In some embodiments, the compositions and methods provided herein are utilized to control undesirable vegetation consisting of grass, broadleaf and sedge weeds.

[0032] In some embodiments, the combination of compound (I) or agriculturally acceptable ester or salt thereof and propyzamide is used to control Amaranthus retroflexus (redroot pigweed, AMARE), Chenopodium album (common lambsquarters, CHEAL), Centaurea cyanus (cornflower, CENCY), Descurainia sophia (flixweed, DESSO), Conyza canadensis (horseweed / marestail, ERICA), Conyza bonariensis (fleabane, ERIBO), Erodium cicutarium (storksbill / redstem filaree, EROCI), Fumaria officinalis (common fumitory, FUMOF), Galeopsis tetrahit (common hemp nettle, GAETE), Galium aparine (bedstraw, catchweed / cleavers, GALAP), Geranium dissectum (cutleaf geranium, GERDI), Geranium pusillum (smallflower geranium, GERPU), Glycine max (volunteer soybean, GLXMA), Lamium amplexicaule (henbit, LAMAM), Lamium amplexicaule (henbit, LAMAM), Lamium purpureum (purple dead nettle, LAMPU), Papaver rhoes (common poppy, PAPRH), Stellaria media (common chickweed, STEME), Veronica persica (Persian speedwell, VERPE), Linum usitatissimum (volunteer flax, LIUUT), Geranium carolinianum (Carolina geranium, GERCA), or Vicia vilosa (hairy vetch, VICVI).

[0033] With regard to the compositions, in some embodiments, the weight ratio of the compound of formula (I) or salt or ester thereof to propyzamide or salt thereof is within the
range of from about 1:2240 to about 1:10. In certain embodiments, the weight ratio of the 
compound of formula (I) or salt or ester thereof to propyzamide or salt thereof is within the 
range of from about 1:600 to about 1:25. In certain embodiments, the weight ratio of the 
compound of formula (I) or salt or ester thereof to propyzamide or salt thereof is within the 
range of from about 1:600 to about 1:30. In certain embodiments, the compositions comprise 
the compound of formula (I) or its methyl ester, TEA salt, or potassium salt and 
propyzamide.

[0034] With respect to the methods, in certain embodiments, the methods comprise 
contacting the undesirable vegetation or locus thereof or applying to the soil to prevent the 
emergence or growth of vegetation a composition described herein. In some embodiments, 
the composition is applied at an application rate of from about 101 grams active ingredient 
per hectare (g ai/ha) to about 2250 g ai/ha based on the total amount of active ingredients in 
the composition. In certain embodiments, the composition is applied at an application rate of 
from about 250 g ai/ha to about 760 g ai/ha based on the total amount of active ingredients in 
the composition. In some embodiments, the methods comprise contacting the undesirable 
vegetation or locus thereof or applying to the soil to prevent the emergence or growth of 
vegetation with a compound of formula (I) or salt or ester thereof and propyzamide, e.g., 
sequentially or simultaneously. In some embodiments, the propyzamide is applied at a rate 
from about 100 g ai/ha to about 2240 g ai/ha and the compound of formula (I) of salt or ester 
thereof is applied at a rate from about 1 gram acid equivalent per hectare (g ae/ha) to about 10 
g ae/ha. In certain embodiments, the methods utilize the compound of formula (I) or its 
methyl ester, TEA salt, or potassium salt in combination with propyzamide.

[0035] The components of the mixtures described herein can be applied either separately or 
as part of a multipart herbicidal system.

[0036] The mixtures described herein can be applied in conjunction with one or more other 
herbicides to control a wider variety of undesirable vegetation. When used in conjunction 
with other herbicides, the composition can be formulated with the other herbicide or 
herbicides, tank-mixed with the other herbicide or herbicides or applied sequentially with the 
other herbicide or herbicides. Some of the herbicides that can be employed in conjunction 
with the compositions and methods described herein include, but are not limited to: 4-CPA, 
4-CPB, 4-CPP, 2,4-D, 2,4-D choline salt, 2,4-D esters and amines, 2,4-DB, 3,4-DA, 3,4-DB, 
2,4-DEB, 2,4-DEP, 3,4-DP, 2,3,6-TBA, 2,4,5-T, 2,4,5-TB, acetochlor, acifluorfen, aclonifen,
acrolein, alachlor, allidochlor, alloxydim, allyl alcohol, alorac, ametridione, ametryn, 
amibuzin, amicarbazone, amidosulfuron, aminocyclopyrachlor, aminopryralid, amiprophos-
methyl, amitrole, ammonium sulfamate, anilofos, anisuron, asulam, atraton, atrazine, 
azafenidin, azimsulfuron, aziprotryne, barban, BCPC, beflubutamid, benazolin, bencarbazone, benfluralin, benfuresate, bensulfuron-methyl, bensulide, benthio carb, 
bentazon-sodium, benzadox, benzfendizone, benzipram, benzobicyclon, benzofenap, 
benzofluor, benzoxylprop, benzthiazuron, bicyclopyrone, bifenox, bilanafos, bispyribac-
chlorate, chloramben, chloranocryl, chlorazifop, chlorazine, chlorbromuron, 
chlorimuron, chlorlindem, chlorlindam, cinidon-ethyl, cinmethylin, 
cinosulfuron, cisanilide, clethodim, clidodine, clodinafop-propargyl, clof, clomazone, clomeprop, clopro, cloproxydim, clopyralid, clorsulam-methyl, clopyralid, 
chlorpropham, chlorlindem, chlorlindam, cinidon-ethyl, cinmethylin, 
cinosulfuron, cisanilide, clethodim, clidodine, clodinafop-propargyl, clof, clomazone, clo metprop, clopro, cloproxydim, clopyralid, clorsulam-methyl, CMA, copper sulfate, 
CPMF, CPPC, creazine, cresol, cumyluron, cytanatryn, cyanazine, cycloate, cyclosulfamuron, cycloxydim, cycluron, cyhalofop-butyl, cyperquat, cyprazine, cyprazole, 
cyromid, dalapon, dazomet, delachlor, desmedipham, desmetryn, di-allate, dicamba, 
dichlobenil, dichloralurea, dichlormate, dichlorprop, dichlorprop-P, diclofop-methyl, 
dicloflurid, diethamquat, diethyland, difenapen, difenoxuron, difenzoquat, diflufencian, 
diflufenzopyr, dimefuron, dimepiperate, dimethachlor, dimethametryn, dimethanamid, 
dimethenamid-P, dimexano, dimidaznon, dinitrizine, dinofen, dinoprop, dinosam, dinoseb, 
dinoterb, diphenamid, dipropetryn, diquat, disul, dithiopyr, diuron, DMPA, DNOC, DSMA, 
EBEP, eglinazine, endothal, erbon, erbon, esprocarb, ethalfluralin, ethbenzamide, 
ethametsulam, ethidimuron, ethiolate, ethoben zamid, etoben amid, ethofumesate, ethoxyfen, ethoxysulfuron, etinofen, etnipro mid, etoben zanid, EXD, fenam, fenoprop, fenoxaprop, fenoxaprop-P-ethyl, fenoxaprop-P-ethyl + isoxadifen-ethyl, fenoxasulfone, 
fenteracol, fentiaprop, fenoxamid, fenuron, ferrous sulfate, flamprop, flamprop-M, 
flazasulfuron, florasulam, fluazifop, fluazifop-P-butyl, fluazolate, flucarbazone, 
flucetosulam, fluchloralin, flufenacet, flufenic acid, flufenpyr-ethyl, flumetsulam, flumezin, 
flumiclorac-pentyl, flumioxazin, flumipropyn, flumetsulam, fluorodifen, fluoroglycofen,
fluoromidine, fluoronitrofen, fluothiuron, flupoxam, flupropacil, flupropanate, flupyr-sulfuron, fluridone, fumiclorac, furyloxyfen, glufosinate, glufosinate-ammonium, glufosinate-P-ammonium, glyphosate, halosafen, halosulfuron-methyl, haloxydine, haloxyfop-methyl, haloxyfop-P-methyl, hexachloroacetone, hexaflurate, hexazinone, imazamethabenz, imazamox, imazapic, imazapyr, imazaquin, imazethapyr, imazosulfuron, indanofan, indaziflam, iodobonil, iodomethane, iodosulfuron, iodosulfuron-ethyl-sodium, iofensulfuron, ioxynil, ipazine, ipfencarbazone, iprymidam, isocarbamid, isocil, isomethiozin, isonoruron, isopolinate, isoproturon, isoxaben, isoxachlortole, isoxaflutole, isoxapryifop, karbutilate, ketospiradox, lactofen, lenacil, linuron, MAA, MAMA, MCPA esters and amines, MCPA-thioethyl, MCPB, mecoprop, mecoprop-P, medinoterb, mfenacet, mefluidide, mesoprazine, mesosulfuron, mesotrione, metam, metamifop, metamitron, metazachlor, metazosulfuron, metflurazone, methabenzthiazuron, methalpropalin, methazole, methiobencarb, methiozolin, methiuron, methomeron, methoprotynure, methyl bromide, methyl isothiocyanate, methyldymron, metobenzuron, metobromuron, metolachlor, methylarsonate, potassium azide, potassium cyanate, pretilachlor, primisulfuron-methyl, procymidine, prodiamine, proflualoz, profuralin, profoxydim, proglazin, prohexadione-calcium, prometyn, prometryn, pronamide, propachlor, propanil, propaquizzafop, propazine, proflumifos, propiconazole, propoxycarbazide, propyrisulfuron, prosulfalin, prosulfocarb, prosulfuron, propanil, pydanon, pyraclonil, pyraflufen-ethyl, pyrasulfotole, pyrazogyl, pyrazolylamine, pyrazosulfuron-ethyl, pyrazoxofen, pyribenzoxim, pyriclor, pyridafol, pyridate, pyrithiobac, pyrithiobac-sodium, pyroxsulfone, pyroxsulam, quinclorac, quinmerac, quinoclamine, quinonamid, quizalofop, quizalofop-P-ethyl, rhodethanil, rimsulfuron, saflufenacil, S-metolachlor, sebuthylazine,
secbumeton, sethoxydim, simazine, simeton, simetryn, SMA, sodium arsenite, sodium azide, sodium chlorate, sulcotrione, sulfallate, sulfentrazone, sulfometuron, sulfosate, sulfosulfuron, sulfuric acid, sulglycapin, swep, TCA, tebutam, tebuthiuron, tefuryltrione, tembotrione, tepraloxydim, terbacil, terbucarb, terbuh chlor, terbumeton, terbuthylazine, terbutryn, tetrafluron, thenylchlor, thiaazafuron, thiazopyr, thidiazimin, thidiazuron, thien carbazole-methyl, thifensulfuron, thifensulfuron-methyl, thiobencarb, tiocarbazil, tioclorim, topramezone, tralkoxydim, triafamone, tri-allate, triasulfuron, triaziflam, tri benuron, tribenuron-methyl, tricamba, triclopyr choline salt, triclopyr esters and salts, tridiphane, trietazine, trifloxysulfuron, trifluralin, triflusulfuron, trifop, trifopsime, trihydroxy triazine, trimeturon, trip ropindan, tritac tritosulfuron, vernolate, xylachlor and salts, esters, optically active isomers and mixtures thereof.

[0037] In some embodiments the methods provided herein are used to control undesirable vegetation in glyphosate-, glufosinate-, dicamba-, phenoxy auxins-, pyridyloxy auxins-, aryloxyphenoxypropionates-, acetyl CoA carboxylase (ACCase) inhibitors-, imidazolinones-, acetolactate synthase (ALS) inhibitors-, 4-hydroxyphenyl-pyruvate dioxygenase (HPPD) inhibitors-, protoporphyrinogen oxidase (PPO) inhibitors-, triazines-inhibitors, or bromoxynil-tolerant crops. Such herbicide tolerant crops may possesses multiple or stacked traits conferring tolerance to multiple herbicides or multiple modes-of-action.

[0038] In some embodiments the methods provided herein are used to control undesirable vegetation that is a herbicide resistant or tolerant weed. Such herbicide resistant or tolerant weed may have a biotype with resistance or tolerance to multiple herbicides, multiple chemical classes, or multiple herbicide modes-of-action. For example, the herbicide resistant or tolerant weed may have a biotype resistant or tolerant to acetolactate synthase (ALS) inhibitors, photosystem II inhibitors, acetyl CoA carboxylase (ACCase) inhibitors, synthetic auxins, photosystem I inhibitors, 5-enolpyruvylshikimate-3-phosphate (EPSP) synthase inhibitors, microtubule assembly inhibitors, lipid synthesis inhibitors, protoporphyrinogen oxidase (PPO) inhibitors, carotenoid biosynthesis inhibitors, very long chain fatty acid (VLCFA) inhibitors, phytoene desaturase (PDS) inhibitors, glutamine synthetase inhibitors, 4-hydroxyphenyl-pyruvate-dioxygenase (HPPD) inhibitors, mitosis inhibitors, cellulose biosynthesis inhibitors, herbicides with multiple modes-of-action, quinclorac, arylaminopropionic acids, difenzoquat, endothall, or organo arsenicals.

[0039] In some embodiments, the compositions described herein are employed in combination with one or more herbicide safeners, such as AD-67 (MON 4660), benoxacor,
benthiocarb, brassinolide, cloquintocet (mexyl), cyometrinil, daimuron, dichlormid, 
dicyclonon, dimepiperate, disulfoton, fenchlorazole-ethyl, fenclorim, flurazone, fluxofenim, 
furilazole, harpin proteins, isoxadifen-ethyl, jiecaowan, jiecaoxi, mefenpyr-diethyl, 
mephenate, naphthalic anhydride (NA), oxabetrinil, R29148 and N-phenyl-sulfonylbenzoic 
acid amides, to enhance their selectivity. In some embodiments, the safeners are employed in 
rice, cereal, corn, or maize settings. In some embodiments, the safener is cloquintocet or an 
ester or salt thereof. In certain embodiments, cloquintocet is utilized to antagonize harmful 
effects of the compositions on rice and cereals. In some embodiments, the safener is 
cloquintocet (mexyl).

[0040] In some embodiments, compositions provided herein further comprise at least one 
agriculturally acceptable adjuvant or carrier. Suitable adjuvants or carriers should not be 
phytotoxic to valuable crops, particularly at the concentrations employed in applying the 
compositions for selective weed control in the presence of crops, and should not react 
chemically with herbicidal components or other composition ingredients. Such mixtures can 
be designed for application directly to weeds or their locus or can be concentrates or 
formulations that are normally diluted with additional carriers and adjuvants before 
application. They can be solids, such as, for example, dusts, granules, water-dispersible 
granules, or wettable powders, or liquids, such as, for example, emulsifiable concentrates, 
solutions, emulsions or suspensions. They can also be provided as a pre-mix or tank-mixed.

[0041] Suitable agricultural adjuvants and carriers include, but are not limited to, crop oil 
concentrate; nonylphenol ethoxylate; benzylcocoalkyldimethyl quaternary ammonium salt; 
blend of petroleum hydrocarbon, alkyl esters, organic acid, and anionic surfactant; C9-C11 
alkylpolyglycoside; phosphated alcohol ethoxylate; natural primary alcohol (C_{12}-C_{16}) 
ethoxylate; di-sebutylphenol EO-PO block copolymer; polysiloxane-methyl cap; 
nonylphenol ethoxylate + urea ammonium nitrate; emulsified methylated seed oil; tridecyl 
alcohol (synthetic) ethoxylate (8EO); tallow amine ethoxylate (15 EO); PEG(400) dioleate- 
99.

[0042] Liquid carriers that can be employed include water and organic solvents. The organic 
solvents include, but are not limited to, petroleum fractions or hydrocarbons such as mineral 
oil, aromatic solvents, paraffinic oils, and the like; vegetable oils such as soybean oil, 
rapseseed oil, olive oil, castor oil, sunflower seed oil, coconut oil, corn oil, cottonseed oil, 
linseed oil, palm oil, peanut oil, safflower oil, sesame oil, tung oil and the like; esters of the
above vegetable oils; esters of monoalcohols or dihydric, trihydric, or other lower polyalcohols (4-6 hydroxy containing), such as 2-ethyl hexyl stearate, n-butyl oleate, isopropyl myristate, propylene glycol dioleate, di-octyl succinate, di-butyl adipate, di-octyl phthalate and the like; esters of mono, di and polycarboxylic acids and the like. Specific organic solvents include, but are not limited to toluene, xylene, petroleum naphtha, crop oil, acetone, methyl ethyl ketone, cyclohexanone, trichloroethylene, ethyl acetate, amyl acetate, butyl acetate, propylene glycol monomethyl ether and diethylene glycol monomethyl ether, methyl alcohol, ethyl alcohol, isopropyl alcohol, amyl alcohol, ethylene glycol, propylene glycol, glycerine, N-methyl-2-pyrrolidinone, N,N-dimethyl alkylamides, dimethyl sulfoxide, liquid fertilizers and the like. In certain embodiments, water is the carrier for the dilution of concentrates.

[0043] Suitable solid carriers include but are not limited to talc, pyrophyllite clay, silica, attapulgus clay, kaolin clay, kieselguhr, chalk, diatomaceous earth, lime, calcium carbonate, bentonite clay, Fuller's earth, cottonseed hulls, wheat flour, soybean flour, pumice, wood flour, walnut shell flour, lignin, cellulose, and the like.

[0044] In some embodiments, the compositions described herein further comprise one or more surface-active agents. In some embodiments, such surface-active agents are employed in both solid and liquid compositions, and in certain embodiments those designed to be diluted with carrier before application. The surface-active agents can be anionic, cationic or nonionic in character and can be employed as emulsifying agents, wetting agents, suspending agents, or for other purposes. Surfactants which may also be used in the present formulations are described, inter alia, in "McCutcheon's Detergents and Emulsifiers Annual," MC Publishing Corp., Ridgewood, New Jersey, 1998 and in "Encyclopedia of Surfactants," Vol. I-III, Chemical Publishing Co., New York, 1980-81. Surface-active agents include, but are not limited to salts of alkyl sulfates, such as diethanolammonium lauryl sulfate; alkylarylsulfonate salts, such as calcium dodecylbenzenesulfonate; alkylphenol-alkylene oxide addition products, such as nonylphenol-C10 ethoxylate; alcohol-alkylene oxide addition products, such as tridecyl alcohol-C16 ethoxylate; soaps, such as sodium stearate; alkyl-naphthalene-sulfonate salts, such as sodium dibutynaphthalenesulfonate; dialkyl esters of sulfo succinate salts, such as sodium di(2-ethylhexyl) sulfo succinate; sorbitol esters, such as sorbitol oleate; quaternary amines, such as lauryl trimethylammonium chloride; polyethylene glycol esters of fatty acids, such as polyethylene glycol stearate; block copolymers of
ethylene oxide and propylene oxide; salts of mono and dialkyl phosphate esters; vegetable or seed oils such as soybean oil, rapeseed/canola oil, olive oil, castor oil, sunflower seed oil, coconut oil, corn oil, cottonseed oil, linseed oil, palm oil, peanut oil, safflower oil, sesame oil, tung oil and the like; and esters of the above vegetable oils, and in certain embodiments, methyl esters.

[0045] In some embodiments, these materials, such as vegetable or seed oils and their esters, can be used interchangeably as an agricultural adjuvant, as a liquid carrier or as a surface active agent.

[0046] Other exemplary additives for use in the compositions provided herein include but are not limited to compatibilizing agents, antifoam agents, sequestering agents, neutralizing agents and buffers, corrosion inhibitors, dyes, odorants, spreading agents, penetration aids, sticking agents, dispersing agents, thickening agents, freezing point depressants, antimicrobial agents, and the like. The compositions may also contain other compatible components, for example, other herbicides, plant growth regulants, fungicides, insecticides, and the like and can be formulated with liquid fertilizers or solid, particulate fertilizer carriers such as ammonium nitrate, urea and the like.

[0047] In some embodiments, the concentration of the active ingredients in the compositions described herein is from about 0.0005 to 98 percent by weight. In some embodiments, the concentration is from about 0.0006 to 90 percent by weight. In compositions designed to be employed as concentrates, the active ingredients, in certain embodiments, are present in a concentration from about 0.1 to 98 weight percent, and in certain embodiments about 0.5 to 90 weight percent. Such compositions are, in certain embodiments, diluted with an inert carrier, such as water, before application. The diluted compositions usually applied to weeds or the locus of weeds contain, in certain embodiments, about 0.0005 to 15.0 weight percent active ingredient and in certain embodiments contain about 0.001 to 12.0 weight percent.

[0048] The present compositions can be applied to weeds or their locus by the use of conventional ground or aerial dusters, sprayers, and granule applicators, by addition to irrigation or paddy water, and by other conventional means known to those skilled in the art.

[0049] The described embodiments and following examples are for illustrative purposes and are not intended to limit the scope of the claims. Other modifications, uses, or combinations with respect to the compositions described herein will be apparent to a person of ordinary skill in the art without departing from the spirit and scope of the claimed subject matter.
EXAMPLES

[0050] Evaluation of Postemergent Herbicidal Activity. Seeds or nutlets of the desired test plant species were planted in Sun Gro Metro-Mix® 360 planting mixture, which typically has a pH of 6.0 to 6.8 and an organic matter content of about 30 percent, in plastic pots with a surface area of 64 square centimeters (cm²). When required to ensure good germination and healthy plants, a fungicide treatment and/or other chemical or physical treatment was applied. The plants were grown for 7-21 days (d) in a greenhouse with an approximate 15 hour (h) photoperiod which was maintained at about 23-29 °C during the day and 22-28 °C during the night. Nutrients and water were added on a regular basis and supplemental lighting was provided with overhead metal halide 1000-Watt lamps as necessary. The plants were employed for testing when they reached the first or second true leaf stage.

[0051] A weighed amount, determined by the highest rate to be tested, of each test compound was placed in a 25 milliliter (mL) glass vial and was dissolved in 4 mL of a 97:3 volume per volume (v/v) mixture of acetone and dimethyl sulfoxide (DMSO) to obtain concentrated stock solutions. If the test compound did not dissolve readily, the mixture was warmed and/or sonicated. The concentrated stock solutions obtained were diluted with 20 mL of an aqueous mixture containing acetone, water, isopropyl alcohol, DMSO, Atplus 411F crop oil concentrate, and Triton® X-155 surfactant in a 48.5:39:10:1.5:1:0:0.02 v/v ratio to obtain spray solutions containing the highest application rates. Additional application rates were obtained by serial dilution of 12 mL of the high rate solution into a solution containing 2 mL of a 97:3 v/v mixture of acetone and DMSO and 10 mL of an aqueous mixture containing acetone, water, isopropyl alcohol, DMSO, Atplus 411F crop oil concentrate, and Triton X-155 surfactant in a 48.5:39:10:1.5:1:0:0.02 v/v ratio to obtain 1/2X, 1/4X, 1/8X and 1/16X rates of the high rate. Compound requirements are based upon a 12 mL application volume at a rate of 187 liters per hectare (L/ha). Formulated compounds were applied to the plant material with an overhead Mandel track sprayer equipped with 8002E nozzles calibrated to deliver 187 L/ha over an application area of 0.503 square meters (m²) at a spray height of 18 inches (43 cm) above the average plant canopy height. Control plants were sprayed in the same manner with the solvent blank.

[0052] Treatments consisted of the methyl ester of 4-amino-3-chloro-6-(4-chloro-2-fluoro-3-methoxyphenyl)pyridine-2-carboxylic acid (Cmpd 1) as technical grade material and
propyzamide (Kerb 50W) alone and in combination. The form of compound of formula (I) was applied on an acid equivalent basis and propyzamide was applied on an active ingredient basis.

[0053] The treated plants and control plants were placed in a greenhouse as described above and watered by subirrigation to prevent wash-off of the test compounds. After 14 d, the condition of the test plants as compared with that of the untreated plants was determined visually and scored on a scale of 0 to 100 percent where 0 corresponds to no injury and 100 corresponds to complete kill. Some of the compounds tested, application rates employed, plant species tested, and results are given in Table 1.

[0054] Results in Table 1 are greenhouse trial results for foliar applied compositions. The observed values in the table refer to percent (%) control rated visually. Colby's equation was used to determine the herbicidal effects expected from the mixtures (Colby, S. R. Calculation of the synergistic and antagonistic response of herbicide combinations. Weeds 1967, 15, 20-22.). More specifically, the following equation was used to calculate the expected activity of mixtures containing two active ingredients, A and B:

$$\text{Expected} = A + B - (A \times B/100)$$

A = observed efficacy of active ingredient A at the same concentration as used in the mixture;

B = observed efficacy of active ingredient B at the same concentration as used in the mixture.

The compositions tested, application rates employed, plant species tested, and results are given in Table 1.

The following abbreviations are used in Table 1:

GLXMA Glycine max (volunteer soybean)

IPOHE Ipomoea hederacea (L.) Jacq. (ivyleaf morningglory)

ABUTH Abutilon theophrasti Medik. (velvetleaf)

POLCO Polygonum convolvulus L. (wild buckwheat)

SETFA Setaria faberii Herrm. (giant foxtail)

BRSNW Brassica napus (winter oilseed rape)

AMARE Amaranthus retroflexus L. (redroot pigweed)

EPHHL Euphorbia heterophylla L. (wild poinsettia)

CHEAL Chenopodium album L. (common lambsquarters)

STEME Stellaria media (L.) Vill. (common chickweed)
VIOTR *Viola tricolor* L. (wild violet)

CIRAR *Cirsium arvense* (L.) Scop. (Canada thistle)

*g ae/ha* = grams acid equivalent per hectare

* g ai/ha = grams active ingredient per hectare

* ob = observed value of % control rated visually

* ex = expected value of % control as calculated by Colby’s equation

* Cmpd I = the methyl ester of the compound of formula (I)
Table 1. Synergistic activity of compositions comprising Cmpd I and Propyzamide - percent (%) control rated visually

<table>
<thead>
<tr>
<th>Treatment</th>
<th>GLXMA</th>
<th>IPOHE</th>
<th>ABUTH</th>
<th>POLCO</th>
<th>SETFA</th>
<th>BRSNW</th>
<th>AMARE</th>
<th>EPHHL</th>
<th>CHEAL</th>
<th>STEME</th>
<th>VIOTR</th>
<th>CIRAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cmpd I (g ae/ha)</td>
<td>Propyzamide (g ai/ha)</td>
<td>ob</td>
<td>ex</td>
<td>ob</td>
<td>ex</td>
<td>ob</td>
<td>ex</td>
<td>ob</td>
<td>ex</td>
<td>ob</td>
<td>ex</td>
<td>ob</td>
</tr>
<tr>
<td>2.5</td>
<td>0</td>
<td>80</td>
<td>-</td>
<td>20</td>
<td>-</td>
<td>87</td>
<td>-</td>
<td>35</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>100</td>
<td>-</td>
<td>43</td>
<td>-</td>
<td>90</td>
<td>-</td>
<td>48</td>
<td>-</td>
<td>35</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>0</td>
<td>285</td>
<td>10</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>570</td>
<td>15</td>
<td>-</td>
<td>17</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>15</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>20</td>
</tr>
<tr>
<td>2.5</td>
<td>285</td>
<td>83</td>
<td>82</td>
<td>55</td>
<td>28</td>
<td>88</td>
<td>87</td>
<td>38</td>
<td>38</td>
<td>0</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>2.5</td>
<td>570</td>
<td>88</td>
<td>83</td>
<td>47</td>
<td>33</td>
<td>93</td>
<td>87</td>
<td>68</td>
<td>45</td>
<td>10</td>
<td>0</td>
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<td>285</td>
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<td>88</td>
<td>63</td>
<td>45</td>
<td>94</td>
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<td>15</td>
</tr>
<tr>
<td>5</td>
<td>570</td>
<td>97</td>
<td>89</td>
<td>70</td>
<td>49</td>
<td>96</td>
<td>85</td>
<td>63</td>
<td>36</td>
<td>40</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>285</td>
<td>96</td>
<td>100</td>
<td>78</td>
<td>49</td>
<td>96</td>
<td>91</td>
<td>80</td>
<td>50</td>
<td>60</td>
<td>35</td>
<td>18</td>
</tr>
<tr>
<td>10</td>
<td>570</td>
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<td>100</td>
<td>78</td>
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<td>90</td>
<td>80</td>
<td>55</td>
<td>68</td>
<td>35</td>
<td>30</td>
</tr>
</tbody>
</table>
Field Trial

[0055] Multiple small plot research experiments were conducted to evaluate efficacy and
tolerance of winter oilseed rape to compositions described herein. Typical small plots (2-4 x
4-10 meters (m)) were used in growers’ fields under natural conditions with normal
commercial cultural practices. Backpack sprayers were used to apply all treatments based on
unit area. The methyl ester of formula (I) and propyzamide were tested alone and in
combination at varying rates. Application water volume was 150 L/ha. Crop stage was at
Growth Stage 39-50. Visual crop injury ratings were collected 32, 49, and 74 days after
treatment. In each case the rating was 0% injury. Control of GERSS, POAAN, and VERSS
was evaluated visually at 32, 58, and 80 days after application. The observed visual percent
(%) control values are reported in the following Tables 2-4. The reported values are means.
Means followed by the same letter do not significantly differ (P=.05, Student-Newman-
Keuls).

[0056] The following abbreviations are used in Tables 2-4:

- GERSS *Geranium* sp. (cranesbill)
- POAAN *Poa annua* (annual bluegrass)
- VERSS *Veronica* sp. (speedwell)

\[ g \text{ ae/ha} = \text{grams acid equivalent per hectare} \]
\[ g \text{ ai/ha} = \text{grams active ingredient per hectare} \]
\[ \text{ob} = \text{observed value} \]
\[ \text{ex} = \text{expected value as calculated by Colby's equation} \]
\[ \text{Cmpd I} = \text{the methyl ester of the compound of formula (I)} \]
\[ \text{DAAA} = \text{days after application A} \]
Table 2. Synergistic activity of compositions comprising Cmpd I and Propyzamide -
percent (%) control rated visually 32 DAAA

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Propyzamide (g ai/ha)</th>
<th>GERSS</th>
<th>POAAN</th>
<th>VEPvSS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cmpd I (g ae/ha)</td>
<td>ob</td>
<td>ex</td>
<td>ob</td>
</tr>
<tr>
<td>250</td>
<td>5.0 e</td>
<td>-</td>
<td>12.5 cd</td>
<td>-</td>
</tr>
<tr>
<td>500</td>
<td>20.0 de</td>
<td>-</td>
<td>15.0 cd</td>
<td>-</td>
</tr>
<tr>
<td>750</td>
<td>18.8 de</td>
<td>-</td>
<td>37.5 a-d</td>
<td>-</td>
</tr>
<tr>
<td>1.25</td>
<td>42.5 cd</td>
<td>-</td>
<td>7.5 cd</td>
<td>-</td>
</tr>
<tr>
<td>2.5</td>
<td>42.5 cd</td>
<td>-</td>
<td>10.0 cd</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>89.3 ab</td>
<td>-</td>
<td>6.3 cd</td>
<td>-</td>
</tr>
<tr>
<td>7.5</td>
<td>91.3 ab</td>
<td>-</td>
<td>28.8 bed</td>
<td>-</td>
</tr>
<tr>
<td>1.25</td>
<td>250 65.0 abc</td>
<td>45.4</td>
<td>15.0 cd</td>
<td>19.1</td>
</tr>
<tr>
<td>1.25</td>
<td>500 42.5 cd</td>
<td>54.0</td>
<td>35.0 a-d</td>
<td>21.4</td>
</tr>
<tr>
<td>1.25</td>
<td>750 56.3 bc</td>
<td>53.3</td>
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<td>42.2</td>
</tr>
<tr>
<td>2.5</td>
<td>250 45.0 cd</td>
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<td>35.0 a-d</td>
<td>21.3</td>
</tr>
<tr>
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<td>500 71.3 abc</td>
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<td>37.5 a-d</td>
<td>23.5</td>
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<tr>
<td>2.5</td>
<td>750 65.0 abc</td>
<td>53.3</td>
<td>48.8 abc</td>
<td>43.8</td>
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<tr>
<td>5</td>
<td>250 90.0 ab</td>
<td>89.8</td>
<td>26.3 bed</td>
<td>18.0</td>
</tr>
<tr>
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<td>500 86.8 ab</td>
<td>91.4</td>
<td>45.0 a-d</td>
<td>20.4</td>
</tr>
<tr>
<td>5</td>
<td>750 86.8 ab</td>
<td>91.3</td>
<td>46.3 a-d</td>
<td>41.4</td>
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<td>750 94.5 a</td>
<td>92.9</td>
<td>61.3 ab</td>
<td>55.5</td>
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</table>
Table 3. Synergistic activity of compositions comprising Cmpd I and Propyzamide - percent (% control rated visually 58 DAAA)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>GERSS</th>
<th>POAAN</th>
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<tr>
<td>Cmpd 1</td>
<td>Propyzamide</td>
<td>ob</td>
</tr>
<tr>
<td>(g ae/ha)</td>
<td>(g ai/ha)</td>
<td></td>
</tr>
<tr>
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<td>17.5</td>
<td>d</td>
</tr>
<tr>
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<td>a</td>
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<tr>
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</tr>
<tr>
<td>7.5</td>
<td>750</td>
<td>93.3</td>
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</table>
Table 4. Synergistic activity of compositions comprising Cmpd I and Propyzamide - percent (%) control rated visually 80 DAAA

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<th>VERSS</th>
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<tr>
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<td>22.5</td>
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<td>a</td>
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<td>7.5</td>
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<td>a</td>
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</tbody>
</table>
WHAT IS CLAIMED IS:

1. A herbicidal composition comprising a herbicidally effective amount of (a) a compound of formula (I)

![Chemical Structure](image)

or an agriculturally acceptable salt or ester thereof and (b) propyzamide.

2. The composition of claim 1, wherein (a) is the methyl ester, triethylammonium (TEA) salt, or potassium salt of compound (I).

3. The composition of any of claims 1 or 2, further comprising a herbicide safener.

4. The composition of any of claims 1-3, wherein the weight ratio of compound of formula (I) or agriculturally acceptable salt or ester thereof to propyzamide is from about 1:2240 to about 1:10.

5. The composition of any of claims 1-3, wherein the weight ratio of compound of formula (I) or agriculturally acceptable salt or ester thereof to propyzamide is from about 1:600 to about 1:25.

6. A herbicidal composition comprising a herbicidally effective amount of two and only two herbicidal active ingredients, wherein the herbicidal active ingredients consist of (a) 4-amino-3-chloro-6-(4-chloro-2-fluoro-3-methoxyphenyl)pyridine-2-carboxylic acid or an agriculturally acceptable ester or salt thereof and (b) propyzamide, and the weight ratio of compound of formula (I) or agriculturally acceptable salt or ester thereof to propyzamide is from about 1:10 to about 1:600.

7. The herbicidal composition of any one of claims 1-6, wherein the composition is synergistic as determined by the Colby equation.
8. A method of controlling undesirable vegetation which comprises contacting the vegetation or the locus thereof with or applying to the soil to prevent the emergence or growth of vegetation the composition of any of claims 1-7.

9. A method of controlling undesirable vegetation which comprises contacting the vegetation or the locus thereof with or applying to the soil or water to prevent the emergence or growth of vegetation a herbicidally effective amount of a compound of the formula (I)

\[
\text{NH}_2
\]
\[
\text{Cl}
\]
\[
\text{Cl}
\]
\[
\text{F}
\]
\[
\text{OCH}_3
\]
\[
\text{OH}
\]
\[
\text{O}
\]

(I)

or an agriculturally acceptable salt or ester thereof and

(b) propyzamide, or a salt thereof.

10. The method of any of claims 8 or 9, wherein the propyzamide is applied at a rate from about 100 g ai/ha to about 2240 g ai/ha and the compound of formula (I) or agriculturally acceptable salt or ester thereof is applied at a rate from about 1 g ae/ha to about 10 g ae/ha.

11. The method of any of claims 8 or 9, wherein the propyzamide is applied at a rate from about 250 g ai/ha to about 750 g ai/ha and the compound of formula (I) or agriculturally acceptable salt or ester thereof is applied at a rate from about 1.25 g ae/ha to about 10 g ae/ha.

12. The method of any of claims 8 or 9, wherein the undesirable vegetation is controlled in winter/spring oilseed rape, winter/spring canola, vegetables, *Brassica* spp, ornamentals, rice, wheat, triticale, barley, oats, rye, sorghum, corn/maize, sunflower, row crops, pastures, grasslands, rangelands, fallowland, sugarcane, turf, tree and vine orchards, industrial vegetation management and rights-of-way.

13. The method of any of claims 8-12, wherein the undesirable vegetation is immature.

14. The method of any of claims 8-12, wherein the (a) and (b) are applied pre-emergently.

15. The method of any of claims 8-12, wherein the (a) and (b) are applied post-emergently.
16. The method of any of claims 8-15, wherein the undesirable vegetation is controlled in a crop that is tolerant to glyphosate, glufosinate, dicamba, phenoxy auxins, pyridyloxy auxins, aryloxyphenoxypropionates, acetyl CoA carboxylase (ACCase) inhibitors, imidazolinones, acetolactate synthase (ALS) inhibitors, 4-hydroxyphenyl-pyruvate dioxygenase (HPPD) inhibitors, protoporphyrinogen oxidase (PPO) inhibitors, triazines, or bromoxynil.

17. The method of claim 16, wherein the tolerant crop possesses multiple or stacked traits conferring tolerance to multiple herbicides or multiple modes-of-action.

18. The method of any of claims 16 or 17, wherein the undesirable vegetation comprises a herbicide resistant or tolerant weed.

19. The method of claim 18, wherein the resistant or tolerant weed is a biotype with resistance or tolerance to multiple herbicides, multiple chemical classes, or multiple herbicide modes-of-action.

20. The method of claim 19, wherein the resistant or tolerant weed is a biotype resistant or tolerant to acetolactate synthase (ALS) inhibitors, photosystem II inhibitors, acetyl CoA carboxylase (ACCase) inhibitors, synthetic auxins, photosystem I inhibitors, 5-enolpyruvylshikimate-3-phosphate (EPSP) synthase inhibitors, microtubule assembly inhibitors, lipid synthesis inhibitors, protoporphyrinogen oxidase (PPO) inhibitors, carotenoid biosynthesis inhibitors, very long chain fatty acid (VLCFA) inhibitors, phytoene desaturase (PDS) inhibitors, glutamine synthetase inhibitors, 4-hydroxyphenyl-pyruvate-dioxygenase (HPPD) inhibitors, mitosis inhibitors, cellulose biosynthesis inhibitors, herbicides with multiple modes-of-action, quinclorac, arylinopropioninc acids, difenzoquat, endothall, or organoarsenicals.

21. The method of any one of claims 8-20 wherein the undesirable vegetation is GLXMA, IPOHE, ABUTH, POLCO, SETFA, BRSNW, AMARE, EPHHL, CHEAL, STEME, VIOTR, CIRRAR, GERSS, POAAN, or VERSS.
A. CLASSIFICATION OF SUBJECT MATTER

<table>
<thead>
<tr>
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<th>USPC</th>
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<td>504/244, 260</td>
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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)

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<tbody>
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</table>

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)


C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
<td>X</td>
<td>WO 2009/029518 A2 (SATCHVIL, N et al.) 05 March 2009; formula 1; page 2, lines 3-10 and 21; page 3, line 1; page 20, lines 1-14 and 22; page 28, lines 1-4; claims 7 and 9</td>
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</tbody>
</table>

Further documents are listed in the continuation of Box C.

- Special categories of cited documents:
  - "A" document defining the general state of the art which is not considered to be of particular relevance
  - "E" earlier application or patent but published on or after the international filing date
  - "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  - "O" document referring to an oral disclosure, use, exhibition or other means
  - "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "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: 18 April 2014 (18.04.2014)

Date of mailing of the international search report: 07 MAY 2014

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450
Facsimile No. 571-273-3201

Authorized officer: Shane Thomas

Form PCT/ISA/210 (second sheet) (July 2009)
## INTERNATIONAL SEARCH REPORT

**International application No.**
PCT/US14/12913

### Box No. II  Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. □ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. □ Claims Nos.:
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos. 4-5, 7-8 and 10-21
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

### Box No. III  Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. □ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. □ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. □ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. □ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- □ The additional search fees were accompanied by the applicant’s protest and, where applicable, the payment of a protest fee.
- ☒ The additional search fees were accompanied by the applicant’s protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- □ No protest accompanied the payment of additional search fees.

Form PCT/SA/2 10 (continuation of first sheet (2)) (July 2009)