

HERBICIDAL COMPOSITIONS COMPRISING 4-AMINO-3-CHLORO-5-FLUORO-6-(4-CHLORO-2-  
FLUORO-3-METHOXYPHENYL) PYRIDINE-2-CARBOXYLIC ACID OR A DERIVATIVE  
THEREOF AND VLCFA SYNTHESIS AND FATTY ACID/LIPID SYNTHESIS INHIBITING  
HERBICIDES

5 Priority Claim

This application claims the benefit of United States provisional patent application number 61/675,105 filed on July 24, 2012, and United States patent application serial number 13/840,306 filed on March 15, 2013, the disclosure of each of which is incorporated herein by reference in its entirety.

Field

10 Provided herein are herbicidal compositions comprising (a) 4-amino-3-chloro-5-fluoro-6-(4-chloro-2-fluoro-3-methoxyphenyl)pyridine-2-carboxylic acid or an agriculturally acceptable ester or salt thereof and (b) very long chain fatty acid (VLCFA) synthesis-inhibiting herbicides and fatty acid/lipid synthesis inhibiting herbicides.

15 Provided herein are also methods of controlling undesirable vegetation comprising applying (a) 4-amino-3-chloro-5-fluoro-6-(4-chloro-2-fluoro-3-methoxyphenyl)pyridine-2-carboxylic acid or an agriculturally acceptable ester or salt thereof and (b) VLCFA and fatty acid/lipid synthesis inhibiting herbicides.

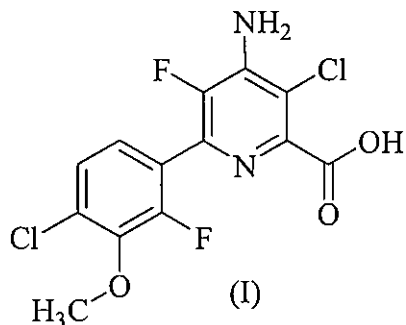
Background

20 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.

25 Summary

Several embodiments are recited below. In the embodiments, the ratio of compound (a) to compound (b) can be expressed in terms of weight to weight (g to g), gae/ha to gae/ha, gae/ha to gai/ha, or gai/ha to gai/ha.

30 1. ——— A first embodiment of the invention provided herein includes synergistic herbicidal compositions comprising a herbicidally effective amount of (a) a compound of the formula (I)



or an agriculturally acceptable salt or ester thereof and (b) VLCFA or fatty acid/lipid synthesis inhibiting herbicides.

2. — ~~The composition of~~ A second embodiment 1, ~~wherein~~ includes the mixture of the first embodiment in which (a) is a C<sub>1-4</sub> alkyl or benzyl ester of compound (I).

3. — ~~The composition of~~ A third embodiment 2, ~~wherein~~ includes the mixture of the first embodiment in which (a) is a benzyl ester of compound (I).

4. — ~~The composition of~~ A fourth embodiment 1, ~~wherein~~ includes the mixture of the first embodiment in which (a) is the compound of formula (I), which is the carboxylic acid.

5. — ~~A fifth embodiment includes the mixture~~ The composition of any of the first through fourth

embodiments 1-4, wherein in which (b) is acetochlor, alachlor, anilofos, benfuresate, cafenstrole, dimethenamid-P, fenoxasulfone, fentrazamide, indanofan, flufenacet, mefenacet, s-metolachlor, molinate, pethoxamid, pretilachlor, prosulfocarb, pyroxasulfone, thenylchlor, or thiobencarb, or an agriculturally acceptable salt thereof.

6. — ~~The composition of~~ A sixth embodiment 1, ~~wherein~~ includes the mixture of the first embodiment in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is acetochlor or acetochlor+dichlormid.

7. — ~~The composition of~~ A seventh embodiment 1, ~~wherein~~ includes the mixture of the first embodiment in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is alachlor.

8. — ~~The composition of~~ An eighth embodiment 1, ~~wherein~~ includes the mixture of the first

embodiment in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is anilofos.

9. — ~~The composition of~~ A ninth embodiment 1, ~~wherein~~ includes the mixture of the first embodiment in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is benfuresate.

10. — ~~The composition of~~ A tenth embodiment 1, ~~wherein~~ includes the mixture of the first embodiment in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is cafenstrole.

11. — ~~The composition of~~ An eleventh embodiment 1, ~~wherein~~ includes the mixture of the first embodiment in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is dimethenamid-P.

12. — ~~The composition of~~ A twelfth embodiment 1, ~~wherein~~ includes the mixture of the first embodiment in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is fenoxasulfone.

13. — ~~The composition of~~ A thirteenth embodiment 1, ~~wherein~~ includes the mixture of the first embodiment in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is fentrazamide.

14. — ~~The composition of~~ A fourteenth embodiment 1, ~~wherein~~ includes the mixture of the first embodiment in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) indanofan.

15. — ~~The composition of A fifteenth embodiment 1, wherein includes the mixture of the first embodiment in which~~ (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is flufenacet.
- 5 16. — ~~The composition of A sixteenth embodiment 1, wherein includes the mixture of the first embodiment in which~~ (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is mefenacet.
17. — ~~The composition of A seventeenth embodiment 1, wherein includes the mixture of the first embodiment in which~~ (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is s-metolachlor.
- 10 18. — ~~The composition of A eighteenth embodiment 1, wherein includes the mixture of the first embodiment in which~~ (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is molinate.
- 15 19. — ~~The composition of A nineteenth embodiment 1, wherein includes the mixture of the first embodiment in which~~ (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is pethoxamid.
- 20 20. — ~~The composition of A twentieth embodiment 1, wherein includes the mixture of the first embodiment in which~~ (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is pretilachlor.
21. — ~~The composition of A twenty-first embodiment 1, wherein includes the mixture of the first embodiment in which~~ (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is prosulfocarb.
22. — ~~The composition of A twenty-second embodiment 1, wherein includes the mixture of the first embodiment in which~~ (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is pyroxasulfone.
- 25 23. — ~~The composition of A twenty-third embodiment 1, wherein includes the mixture of the first embodiment in which~~ (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is thenylchlor.
24. — ~~The composition of A twenty-fourth embodiment 1, wherein includes the mixture of the first embodiment in which~~ (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is thiobencarb.
- 30 25. — ~~The composition of A twenty-fifth embodiment 1, wherein includes the mixture of the first through twenty-fourth embodiments 1-24,~~ further comprising a herbicide safener.
26. — ~~The composition of A twenty-sixth embodiment 5, wherein includes the mixture of the fifth embodiment in which~~ the weight ratio of compound of formula (I) or agriculturally acceptable salt or ester thereof to acetochlor or agriculturally acceptable salt or ester thereof is from about 1:1680 to about 6:1.
- 35 27. — ~~The composition of A twenty-seventh embodiment 5 wherein includes the mixture of the fifth embodiment in which~~ the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to alachlor or agriculturally acceptable salt or ester thereof is from about 1:3350 to about 2:1.

28. — The composition of A twenty-eighth embodiment 5, wherein includes the mixture of the fifth embodiment in which the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to anilofos or agriculturally acceptable salt or ester thereof is from about 1:250 to about 6:1.
- 5 29. — The composition of A twenty-ninth embodiment 5, wherein includes the mixture of the fifth embodiment in which the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to benfuresate or agriculturally acceptable salt or ester thereof is from about 1:300 to about 6:1.
- 10 30. The composition of A thirtieth embodiment 5, wherein includes the mixture of the fifth embodiment in which the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to cafenstrole or agriculturally acceptable salt or ester thereof is from about 1:150 to about 12:1.
31. The composition of A thirty-first embodiment 5, wherein includes the mixture of the fifth embodiment in which the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to dimethenamid-P or agriculturally acceptable salt or ester thereof is from about 1:850 to about 1:1.
- 15 32. The composition of A thirty-second embodiment 5, wherein includes the mixture of the fifth embodiment in which the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to fenoxasulfone or agriculturally acceptable salt or ester thereof is from about 1:250 to about 6:1.
- 20 33. The composition of A thirty-third embodiment 5, wherein includes the mixture of the fifth embodiment in which the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to fentrazamide or agriculturally acceptable salt or ester thereof is from about 1:150 to about 19:1.
34. The composition of A thirty-fourth embodiment 5, wherein includes the mixture of the fifth embodiment in which the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to indanofan or agriculturally acceptable salt or ester thereof is from about 1:150 to about 12:1.
- 25 35. The composition of A thirty-fifth embodiment 5, wherein includes the mixture of the fifth embodiment in which the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to flufenacet or agriculturally acceptable salt or ester thereof is from about 1:625 to about 12:1.
36. — The composition of A thirty-sixth embodiment 5, wherein includes the mixture of the fifth embodiment in which the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to mefenacet or agriculturally acceptable salt or ester thereof is from about 1:800 to about 1:1.
- 30 37. The composition of A thirty-seventh embodiment 5, wherein includes the mixture of the fifth embodiment in which the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to s-metolachlor or agriculturally acceptable salt or ester thereof is from about 1:1500 to about 4:1.
- 35 38. — The composition of A thirty-eighth embodiment 5, wherein includes the mixture of the fifth embodiment in which the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to molinate or agriculturally acceptable salt or ester thereof is from about 1:2780 to about 1:1.

39. The composition of A thirty-ninth embodiment 5, wherein includes the mixture of the fifth embodiment in which the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to pethoxamid or agriculturally acceptable salt or ester thereof is from about 1:625 to about 1.5:1.

40. The composition of A fortieth embodiment 5, wherein includes the mixture of the fifth embodiment in which the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to pretilachlor or agriculturally acceptable salt or ester thereof is from about 1:375 to about 8:1.

41. The composition of A forty-first embodiment 5, wherein includes the mixture of the fifth embodiment in which the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to prosulfocarb or agriculturally acceptable salt or ester thereof is from about 1:2000 to about 1:1.5.

42. The composition of A forty-second embodiment 5, wherein includes the mixture of the fifth embodiment in which the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to pyroxasulfone or agriculturally acceptable salt or ester thereof is from about 1:200 to about 12:1.

43. The composition of A forty-third embodiment 5, wherein includes the mixture of the fifth embodiment in which the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to thenylchlor or agriculturally acceptable salt or ester thereof is from about 1:375 to about 4:1.

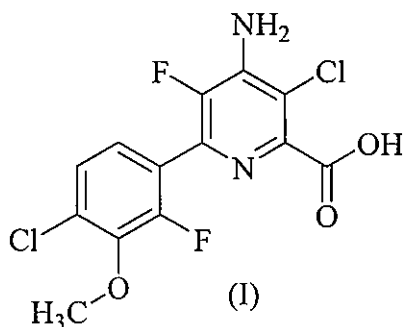
44. The composition of A forty-fourth embodiment 5, wherein includes the mixture of the fifth embodiment in which the weight ratio of the compound of formula (I) or agriculturally acceptable salt or ester thereof to thiobencarb or agriculturally acceptable salt or ester thereof is from about 1:2250 to about 1:2.

45. —The composition A forty-fifth embodiment includes the mixture of any of embodiments 1-44 further comprising an agriculturally acceptable adjuvant or carrier.

46. —The composition A forty-sixth embodiment includes the mixture of any of embodiments 1-44, which is synergistic as determined by the Colby equation.

47. —A forty-seventh embodiment includes 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 the composition of any of embodiments 1-46.

48. —A forty-eighth embodiment includes 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) a compound of the formula (I)



or an agriculturally acceptable salt or ester thereof and (b) a VLCFA or fatty acid/lipid synthesis inhibiting herbicide.

49. — ~~The~~A forty-ninth embodiment includes the method of the forty-seventh or forty-eighth embodiment 47 or 48, ~~wherein~~ in which the method is practiced in at least one member of the group consisting of direct-seeded, water-seeded and transplanted rice, cereals, wheat, barley, oats, rye, sorghum, corn/maize, sugarcane, sunflower, oilseed rape, canola, sugar beet, soybean, cotton, pineapple, pastures, grasslands, rangelands, fallowland, turf, tree and vine orchards, aquatics, plantation crops, vegetables, industrial vegetation management (IVM) or rights-of-way (ROW).
50. — ~~The~~A fiftieth embodiment includes the method of the forty-seventh or forty-eighth embodiment 47 or 48, ~~wherein~~ in which the undesirable vegetation is immature.
51. — ~~The~~A fifty-first embodiment includes the method of the forty-seventh or forty-eighth embodiment 47 or 48, ~~wherein~~ in which the (a) and (b) are applied to water.
52. — ~~The~~A fifty-second embodiment includes the method of the fifty-first embodiment 51, ~~wherein~~ in which the water is part of a flooded rice paddy.
53. — ~~The~~A fifty-third embodiment includes the method of the forty-seventh or forty-eighth embodiment 47 or 48, ~~wherein~~ in which the (a) and (b) are applied pre-emergently to the weed or the crop.
54. — ~~The~~A fifty-fourth embodiment includes the method of the forty-seventh or forty-eighth embodiment 47 or 48, ~~wherein~~ in which the (a) and (b) are applied post-emergently to the weed or the crop.
55. — ~~The~~A fifty-fifth embodiment includes the method of the forty-seventh or forty-eighth ~~any of~~ embodiments 47 or 48, ~~wherein~~ in which the undesirable vegetation is controlled in glyphosate-, 5-enolpyruvylshikimate-3-phosphate (EPSP) synthase inhibitor-, glufosinate-, glutamine synthetase inhibitor-, dicamba-, phenoxy auxin-, pyridyloxy auxin-, synthetic auxin-, auxin transport inhibitor-, aryloxyphenoxypropionate-, cyclohexanedione-, phenylpyrazoline-, acetyl CoA carboxylase (ACCase) inhibitor-, imidazolinones-, sulfonyleurea-, pyrimidinylthiobenzoate-, triazolopyrimidine-, sulfonaminocarbonyltriazolinone-, acetolactate synthase (ALS) or acetohydroxy acid synthase (AHAS) inhibitor-, 4-hydroxyphenyl-pyruvate dioxygenase (HPPD) inhibitor-, phytoene desaturase inhibitor-, carotenoid biosynthesis inhibitor-, protoporphyrinogen oxidase (PPO) inhibitor-, cellulose biosynthesis inhibitor-, mitosis inhibitor-, microtubule inhibitor-, very long chain fatty acid inhibitor-, fatty acid and lipid biosynthesis inhibitor-, photosystem I inhibitor-, photosystem II inhibitor-, triazine-, or bromoxynil-tolerant crops.
56. — ~~The~~A fifty-sixth embodiment includes the method of the fifty-third embodiment 53, ~~wherein~~ in which the tolerant crop possesses multiple or stacked traits conferring tolerance to multiple herbicides or multiple herbicide modes of action.
57. — ~~The~~A fifty-seventh embodiment includes the method of the forty-seventh or forty-eighth embodiment 47 or 48, ~~wherein~~ in which the undesirable vegetation comprises a herbicide resistant or tolerant weed.
58. — ~~The~~A fifty eighth embodiment includes the method of the fifty-seventh embodiment 57, ~~wherein~~ in which the resistant or tolerant weed is a biotype with resistance or tolerance to multiple herbicides, multiple chemical classes, multiple herbicide modes-of-action or via multiple resistance mechanisms.

59. — The A fifty-ninth embodiment includes the method of the fifty-eighth embodiment 58, wherein in which the resistant or tolerant weed is a biotype resistant or tolerant to acetolactate synthase (ALS) or acetohydroxy acid synthase (AHAS) inhibitors, photosystem II inhibitors, acetyl CoA carboxylase (ACCase) inhibitors, synthetic auxins, auxin transport inhibitors, photosystem I inhibitors, 5-enolpyruvylshikimate-3-phosphate (EPSP) synthase inhibitors, microtubule assembly inhibitors, fatty acid and lipid synthesis inhibitors, protoporphyrinogen oxidase (PPO) inhibitors, carotenoid biosynthesis inhibitors, very long chain fatty acid (VLCFA) synthesis 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 organoarsenicals.
60. — The composition A sixtieth embodiment includes the mixture of any of the first through fifth embodiments 1-5, wherein in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is acetochlor or acetochlor+dichlormid.
61. — The composition A sixty-first embodiment includes the mixture of any of the first through fifth embodiments 1-5, wherein in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is alachlor.
62. — The composition A sixty-second embodiment includes the mixture of any of the first through fifth embodiments 1-5, wherein in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is anilofos.
63. — The composition A sixty-third embodiment includes the mixture of any of the first through fifth embodiments 1-5, wherein in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is benfuresate.
64. — The composition A sixty-fourth embodiment includes the mixture of any of the first through fifth embodiments 1-5, wherein in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is cafenstrole.
65. — The composition A sixty-fifth embodiment includes the mixture of any of the first through fifth embodiments 1-5, wherein in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is dimethenamid-P.
66. — The composition A sixty-sixth embodiment includes the mixture of any of the first through fifth embodiments 1-5, wherein in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is fenoxasulfone.
67. — The composition A sixty-seventh embodiment includes the mixture of any of the first through fifth embodiments 1-5, wherein in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) is fentrazamide.
68. — The composition A sixty-eighth embodiment includes the mixture of any of the first through fifth embodiments 1-5, wherein in which (a) is the compound of formula (I) or an agriculturally acceptable benzyl ester and (b) indanofan.

69. — ~~The composition A sixty-ninth embodiment includes the mixture of any of the first through fifth~~  
~~embodiments 1-5, wherein in which~~ (a) is the compound of formula (I) or an agriculturally acceptable  
benzyl ester and (b) is flufenacet.
- 5 70. — ~~The composition A seventieth embodiment includes the mixture of any of the first through fifth~~  
~~embodiments 1-5, wherein in which~~ (a) is the compound of formula (I) or an agriculturally acceptable  
benzyl ester and (b) is mefenacet.
70. — ~~The composition A seventy-first embodiment includes the mixture of any of the first through fifth~~  
~~embodiments 1-5, wherein in which~~ (a) is the compound of formula (I) or an agriculturally acceptable  
benzyl ester and (b) is s-metolachlor.
- 10 72. — ~~The composition A seventy-second embodiment includes the mixture of any of the first through~~  
~~fifth~~ embodiments 1-5, wherein in which (a) is the compound of formula (I) or an agriculturally acceptable  
benzyl ester and (b) is molinate.
- 15 73. — ~~The composition A seventy-third embodiment includes the mixture of any of the first through fifth~~  
~~embodiments 1-5, wherein in which~~ (a) is the compound of formula (I) or an agriculturally acceptable  
benzyl ester and (b) is pethoxamid.
74. — ~~The composition A seventy-fourth embodiment includes the mixture of any of the first through~~  
~~fifth~~ embodiments 1-5, wherein in which (a) is the compound of formula (I) or an agriculturally acceptable  
benzyl ester and (b) is pretilachlor.
- 20 75. — ~~The composition A seventy-fifth embodiment includes the mixture of any of the first through fifth~~  
~~embodiments 1-5, wherein in which~~ (a) is the compound of formula (I) or an agriculturally acceptable  
benzyl ester and (b) is prosulfocarb.
76. — ~~The composition A seventy-sixth embodiment includes the mixture of any of the first through fifth~~  
~~embodiments 1-5, wherein in which~~ (a) is the compound of formula (I) or an agriculturally acceptable  
benzyl ester and (b) is pyroxasulfone.
- 25 77. — ~~The composition A seventy-seventh embodiment includes the mixture of any of the first through~~  
~~fifth~~ embodiments 1-5, wherein in which (a) is the compound of formula (I) or an agriculturally acceptable  
benzyl ester and (b) is thenylchlor.
78. — ~~The composition A seventy-eighth embodiment includes the mixture of any of the first through~~  
~~fifth~~ embodiments 1-5, wherein in which (a) is the compound of formula (I) or an agriculturally acceptable  
30 benzyl ester and (b) is thiobencarb.
79. — ~~The composition A seventy-ninth embodiment includes the mixture of any of the first through~~  
~~forty-eighth or sixtieth through seventy-eighth~~ embodiments 1-48 or 60-78, further comprising a herbicide  
safener.
- 35 80. — ~~The composition An eightieth embodiment includes the mixture of any of the first through fifth~~  
~~embodiments 1-5, wherein in which~~ the weight ratio of compound of formula (I) or agriculturally  
acceptable salt or ester thereof to acetochlor or agriculturally acceptable salt or ester thereof is from about  
1:1680 to about 6:1.

81. — ~~The composition~~ An eighty-first embodiment includes the mixture of any of the first through fifth  
embodiments 1-5 wherein in which the weight ratio of the compound of formula (I) or agriculturally  
acceptable salt or ester thereof to alachlor or agriculturally acceptable salt or ester thereof is from about  
1:3350 to about 2:1.
- 5 82. — ~~The composition~~ An eighty-second embodiment includes the mixture of any of the first through  
fifth embodiments 1-5 wherein in which the weight ratio of the compound of formula (I) or agriculturally  
acceptable salt or ester thereof to anilofos or agriculturally acceptable salt or ester thereof is from about  
1:250 to about 6:1.
- 10 83. — ~~The composition~~ An eighty-third embodiment includes the mixture of any of the first through fifth  
embodiments 1-5 wherein in which the weight ratio of the compound of formula (I) or agriculturally  
acceptable salt or ester thereof to benfuresate or agriculturally acceptable salt or ester thereof is from about  
1:300 to about 6:1.
- 15 84. — ~~The composition~~ An eighty-fourth embodiment includes the mixture of any of the first through  
fifth embodiments 1-5 wherein in which the weight ratio of the compound of formula (I) or agriculturally  
acceptable salt or ester thereof to cafenstrole or agriculturally acceptable salt or ester thereof is from about  
1:150 to about 12:1.
- 20 85. — ~~The composition~~ An eighty-fifth embodiment includes the mixture of any of the first through fifth  
embodiments 1-5 wherein in which the weight ratio of the compound of formula (I) or agriculturally  
acceptable salt or ester thereof to dimethenamid-P or agriculturally acceptable salt or ester thereof is from  
about 1:850 to about 1:1.
- 25 86. — ~~The composition~~ An eighty-sixth embodiment includes the mixture of any of the first through fifth  
embodiments 1-5 wherein in which the weight ratio of the compound of formula (I) or agriculturally  
acceptable salt or ester thereof to fenoxasulfone or agriculturally acceptable salt or ester thereof is from  
about 1:250 to about 6:1.
- 30 87. — ~~The composition~~ An eighty-seventh embodiment includes the mixture of any of the first through  
fifth embodiments 1-5 wherein in which the weight ratio of the compound of formula (I) or agriculturally  
acceptable salt or ester thereof to fentrazamide or agriculturally acceptable salt or ester thereof is from  
about 1:150 to about 19:1.
- 35 88. — ~~The composition~~ An eighty-eighth embodiment includes the mixture of any of the first through  
fifth embodiments 1-5 wherein in which the weight ratio of the compound of formula (I) or agriculturally  
acceptable salt or ester thereof to indanofan or agriculturally acceptable salt or ester thereof is from about  
1:150 to about 12:1.
89. — ~~The composition~~ An eighty-ninth embodiment includes the mixture of any of the first through fifth  
embodiments 1-5 wherein in which the weight ratio of the compound of formula (I) or agriculturally  
acceptable salt or ester thereof to flufenacet or agriculturally acceptable salt or ester thereof is from about  
1:625 to about 12:1.
90. — ~~The composition~~ A ninetieth embodiment includes the mixture of any of the first through fifth  
embodiments 1-5 wherein in which the weight ratio of the compound of formula (I) or agriculturally

acceptable salt or ester thereof to mefenacet or agriculturally acceptable salt or ester thereof is from about 1:800 to about 1:1.

91.—~~The composition~~ A ninety-first embodiment includes the mixture of any of the first through fifth  
embodiments 1-5, wherein in which the weight ratio of the compound of formula (I) or agriculturally  
acceptable salt or ester thereof to s-metolachlor or agriculturally acceptable salt or ester thereof is from  
about 1:1500 to about 4:1.

92.—~~The composition~~ A ninety-second embodiment includes the mixture of any of the first through  
fifth embodiments 1-5, wherein in which the weight ratio of the compound of formula (I) or agriculturally  
acceptable salt or ester thereof to molinate or agriculturally acceptable salt or ester thereof is from about  
1:2780 to about 1:1.

93.—~~The composition~~ A ninety-third embodiment includes the mixture of any of the first through fifth  
embodiments 1-5, wherein in which the weight ratio of the compound of formula (I) or agriculturally  
acceptable salt or ester thereof to pethoxamid or agriculturally acceptable salt or ester thereof is from about  
1:625 to about 1.5:1.

94.—~~The composition~~ A ninety-fourth embodiment includes the mixture of any of the first through fifth  
embodiments 1-5, wherein in which the weight ratio of the compound of formula (I) or agriculturally  
acceptable salt or ester thereof to pretilachlor or agriculturally acceptable salt or ester thereof is from about  
1:375 to about 8:1.

95.—~~The composition~~ A ninety-fifth embodiment includes the mixture of any of the first through fifth  
embodiments 1-5, wherein in which the weight ratio of the compound of formula (I) or agriculturally  
acceptable salt or ester thereof to prosulfocarb or agriculturally acceptable salt or ester thereof is from  
about 1:2000 to about 1:1.5.

96.—~~The composition~~ A ninety-sixth embodiment includes the mixture of any of the first through fifth  
embodiments 1-5, wherein in which the weight ratio of the compound of formula (I) or agriculturally  
acceptable salt or ester thereof to pyroxasulfone or agriculturally acceptable salt or ester thereof is from  
about 1:200 to about 12:1.

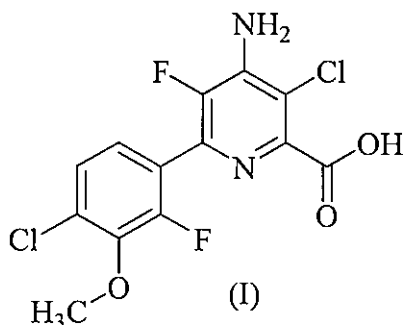
97.—~~The composition~~ A ninety-seventh embodiment includes the mixture of any of the first through  
fifth embodiments 1-5, wherein in which the weight ratio of the compound of formula (I) or agriculturally  
acceptable salt or ester thereof to thenylchlor or agriculturally acceptable salt or ester thereof is from about  
1:375 to about 4:1.

98.—~~The composition~~ A ninety-eighth embodiment includes the mixture of any of the first through fifth  
embodiments 1-5, wherein in which the weight ratio of the compound of formula (I) or agriculturally  
acceptable salt or ester thereof to thiobencarb or agriculturally acceptable salt or ester thereof is from about  
1:2250 to about 1:2.

99.—~~The composition~~ A ninety-ninth embodiment includes the mixture of any of the first through  
forty-eighth or sixtieth through ninety-eighth embodiments 1-48 or 60-98 further comprising an  
agriculturally acceptable adjuvant or carrier.

100. The composition A one-hundredth embodiment includes the mixture of any of the first through forty-eighth or sixtieth through ninety-ninth embodiments 1-48 or 60-99, which is synergistic as determined by the Colby equation.

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



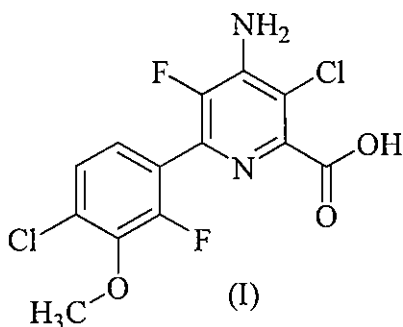
10 or an agriculturally acceptable salt or ester of thereof, and (b) VLCFA and fatty acid/lipid synthesis inhibiting herbicides. Exemplary inhibiting herbicides include, but are not limited to, acetochlor, alachlor, anilofos, benfuresate, cafenstrole, dimethenamid-P, fenoxasulfone, fentrazamide, indanofan, flufenacet, mefenacet, s-metolachlor, molinate, pethoxamid, pretilachlor, prosulfocarb, pyroxasulfone, thenylchlor and thiobencarb, or acceptable salts and esters thereof. The compositions may also contain an agriculturally acceptable adjuvant or carrier.

15 Provided herein are also methods of controlling undesirable vegetation comprising applying (a) a compound of formula (I) or an agriculturally acceptable ester or salt thereof and (b) VLCFA and fatty acid/lipid synthesis inhibiting herbicides.

#### Detailed Description

#### DEFINITIONS

As used herein, the compound of formula (I) has the following structure:



20 The compound of formula (I) can be identified by the name 4-amino-3-chloro-6-(4-chloro-2-fluoro-3-methoxyphenyl)-5-fluoropyridine-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 grass, broadleaf and sedge weeds, in multiple non-crop and cropping situations.

|    |     |    |    |
|----|-----|----|----|
| 16 | 275 | 95 | 88 |
| 32 | 275 | 95 | 97 |

| Compound<br>A Benzyl<br>Ester | Dimethenamid-<br>P | Visual Weed<br>Control (%) -<br>20 DAA |     |
|-------------------------------|--------------------|----------------------------------------|-----|
|                               |                    | CYPES                                  |     |
| gae/ha                        | gai/ha             | Obs                                    | Exp |
| 8                             | 0                  | 0                                      | -   |
| 16                            | 0                  | 75                                     | -   |
| 0                             | 275                | 0                                      | -   |
| 8                             | 275                | 100                                    | 0   |
| 16                            | 275                | 100                                    | 75  |

Table 20. Synergistic Activity of Foliar-Applied Compound A Benzyl Ester and Flufenacet Herbicidal Compositions on Weed Control in a Rice Cropping System.

5

| Compound<br>A Benzyl<br>Ester | Flufenacet | Visual Weed<br>Control (%) - 22<br>DAA |     |
|-------------------------------|------------|----------------------------------------|-----|
|                               |            | BRAPP                                  |     |
| gae/ha                        | gai/ha     | Obs                                    | Exp |
| 8                             | 0          | 60                                     | -   |
| 16                            | 0          | 60                                     | -   |
| 32                            | 0          | 90                                     | -   |
| 0                             | 187.5      | 10                                     | -   |
| 0                             | 375        | 20                                     | -   |
| 0                             | 750        | 40                                     | -   |
| 8                             | 187.5      | 80                                     | 64  |
| 16                            | 187.5      | 90                                     | 64  |
| 32                            | 187.5      | 90                                     | 91  |
| 8                             | 375        | 75                                     | 68  |
| 16                            | 375        | 90                                     | 68  |
| 32                            | 375        | 95                                     | 92  |
| 8                             | 750        | 80                                     | 76  |
| 16                            | 750        | 95                                     | 76  |
| 32                            | 750        | 95                                     | 94  |

Table 21. Synergistic Activity of Foliar-Applied Compound A Benzyl Ester and Indanofan Herbicidal Compositions on Weed Control in a Rice Cropping System.

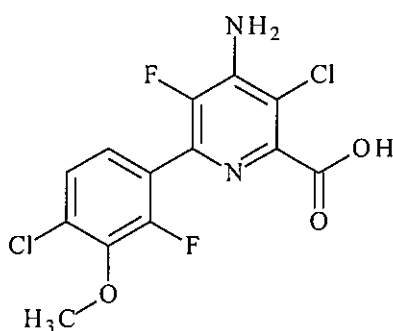
halide 1000-Watt lamps as necessary. The plants were employed for testing when they reached the first through fourth true leaf stage.

Treatments consisted of the acid or esters of 4-amino-3-chloro-5-fluoro-6-(4-chloro-2-fluoro-3-methoxy-phenyl)pyridine-2-carboxylic acid (compound A) each formulated as an

5 SC (suspension concentrate) and various herbicidal components alone and in combination.

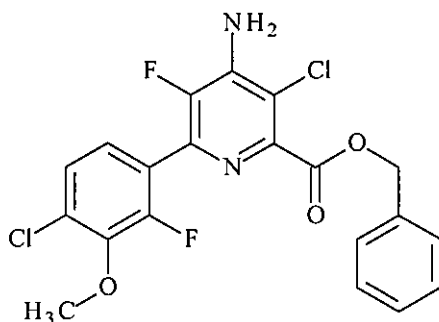
Forms of compound A were applied on an acid equivalent basis.

Forms of compound A (compound of formula I) tested include:



10

Compound A Acid



Compound A Benzyl Ester

The herbicidal components were applied on an active ingredient basis and included very long

15 chain fatty acid (VLCFA) synthesis-inhibiting and fatty acid/lipid synthesis-inhibiting

herbicides acetochlor (technical grade material), acetochlor + dichlormid formulated as

Topnotch<sup>®</sup>, pretilachlor (technical grade material), butachlor formulated as Butachlor EC,

fentrazamide formulated as Fentrazamide EC, thiobencarb formulated as Bolero<sup>®</sup> 8EC,

cafenstrole formulated as Himeadow<sup>®</sup> WP or Lapost<sup>®</sup> Flowable, benfuresate formulated as

20 Full Shot<sup>®</sup>, anilofos (technical grade material), mefenacet (technical grade material), molinate

(technical grade material), and thenylchlor (technical grade material).

|    |     |     |    |
|----|-----|-----|----|
| 16 | 0   | 0   | -  |
| 32 | 0   | 85  | -  |
| 0  | 100 | 0   | -  |
| 0  | 200 | 0   | -  |
| 0  | 400 | 10  | -  |
| 8  | 100 | 0   | 0  |
| 16 | 100 | 20  | 0  |
| 32 | 100 | 100 | 85 |
| 8  | 200 | 10  | 0  |
| 16 | 200 | 40  | 0  |
| 32 | 200 | 100 | 85 |
| 8  | 400 | 25  | 10 |
| 16 | 400 | 30  | 10 |
| 32 | 400 | 100 | 87 |

Table 45. Synergistic Activity of In-Water Applications of Compound A Benzyl Ester and Indanofan Herbicidal Compositions on Weed Control in a Rice Cropping System.

| Compound A Benzyl Ester | Indanofan | Visual Weed Control (%) - 19 DAA |     |
|-------------------------|-----------|----------------------------------|-----|
|                         |           | LEFCH                            |     |
| gae/ha                  | gai/ha    | Obs                              | Exp |
| 8                       | 0         | 0                                | -   |
| 16                      | 0         | 0                                | -   |
| 32                      | 0         | 15                               | -   |
| 0                       | 37.5      | 10                               | -   |
| 0                       | 75        | 20                               | -   |
| 0                       | 150       | 95                               | -   |
| 8                       | 37.5      | 15                               | 10  |
| 16                      | 37.5      | 25                               | 10  |
| 32                      | 37.5      | 25                               | 24  |
| 8                       | 75        | 30                               | 20  |
| 16                      | 75        | 20                               | 20  |
| 32                      | 75        | 60                               | 32  |
| 8                       | 150       | 100                              | 95  |
| 16                      | 150       | 40                               | 95  |
| 32                      | 150       | 100                              | 96  |

5

Table 46. Synergistic Activity of In-Water Applications of Compound A Benzyl Ester and Mefenacet Herbicidal Compositions on Weed Control in a Rice Cropping System.