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क) आवेदन संख्या/a) Application Number: **201731028212**

ख) फाइल करने की तारीख/b) Date of Filing: **8th August' 2017**

ग) अनुरोधित दस्तावेज़(जों) का नाम:

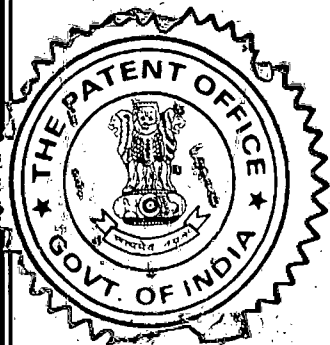
C) Name of the document(s) requested: **Provisional Specification with Form-2 and Form-1**

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FORM 2

THE PATENTS ACT, 1970

(39 of 1970)

&

The Patents Rules, 2003

PROVISIONAL SPECIFICATION

(See section 10; rule 13)

5

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1. Title of the invention - **SYNERGISTIC HERBICIDAL
COMBINATIONS**

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2. Applicant(s)

20

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(b) NATIONALITY : **An Indian Company**

25

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3. PREAMBLE TO THE DESCRIPTION

35

The following specification describes the invention

Technical Field:

The present invention relates to a herbicidal combination for controlling
5 undesirable plants. The present invention more specifically relates to a synergistic
combination of herbicides for controlling weeds.

Background and prior art:

Unwanted plants such as weeds effect soil resources available for cultivated crops
10 and can lead to a decrease in yield and eventually crop loss. Modern herbicides
are used to either control or suppress these undesirable plants so as to allow
sown crops a greater share of nutrients. Farmers usually control these plants at
the pre-plant stage as well as after sowing.

15 Current practices include combining herbicides with varied modes of action,
which allows for broader spectrum of control and resistance management. The
herbicidal effectiveness of a compound cannot be predicted from an examination
of the substituent groups of the compound. Often quite closely related
compounds possess different weed control abilities. Various herbicides of the
20 same class of compounds may have complementary areas of activity and thus can
be useful to control a variety of weeds upon application of a combination.
Furthermore, the various herbicides are not completely effective so as to control
all the infesting weeds in a field crop, which necessitates the use of herbicidal
combinations.

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Synthetic Auxins are used for controlling broadleaf weeds in grass crops, pastures,
and industry. These are readily absorbed through both roots and foliage and

translocate by phloem or xylem to meristematic tissue interfering with cell formation that results in abnormal root and shoot growth. Application of these herbicides results in the disruption of several growth processes in susceptible plants which likely affects cell wall plasticity and nucleic acid metabolism as well as protein synthesis, cell division and growth, and stimulate ethylene evolution, which may in some cases produce the characteristic epinastic symptoms associated with exposure to these herbicides.

Picloram is a synthetic auxin which controls broadleaf weeds. Combination of Picloram with other herbicides are known from **WO2014093210A1 (Ovalle et.al)** or **WO2014202092A1 (Schlosser et.al)**. Ovalle et al teach a combination comprising picloram with aminocyclopyrachlor. Schlosser et al teach a combination comprising picloram and pethoxamid.

2,4-D is a synthetic auxin used for the control of broad-leaved weeds. Combinations of 2,4D with other herbicides are known in the prior art including glyphosate (WO2010123871 A1), glufosinate (WO2015089014 A1) and other herbicides.

Herbicides that inhibit acetolactate synthase (ALS) enzyme are broad spectrum herbicides. These herbicides are an excellent tool for controlling post emergent herbicide for broad leaf weed control in various crops.

Combinations of herbicides are used to control a broader range of weeds. However, the combination of herbicides may not always result in the desired effect. Combination of herbicides may lead to an additive effect or an antagonistic effect. It may also result in phytotoxicity to the crops making it an undesirable

combination. Agronomists must therefore, carefully select the herbicides that can be combined to offer a synergistic effect that would control weeds while having no phytotoxic effect on the crop, and reduce the chances of development of herbicide resistant weeds. There still remains a need for improved herbicidal combinations that can effectively control weeds thereby improving yield and plant health, with reduced phytotoxicity.

There is therefore a need in the art for combinations that have advantageous properties such as an herbicidal combination that is synergistic, helps in resistance management, reduces dosage of herbicides used thus causing minimal damage to the environment, or a herbicidal combination that has excellent residual effects.

Embodiments of the present invention may therefore ameliorate one or more of the above mentioned problems:

Objects of the invention:

Therefore, one object of the present invention is to provide a synergistic herbicidal combination.

Another object of the present invention is to provide a method of controlling weeds at a locus by application of a synergistic herbicidal combination.

Another object of the present invention is to provide a composition comprising a synergistic herbicidal combination.

Another object of the present invention is to provide a method of controlling herbicide resistant weeds.

Yet another object of the present invention is to provide a method of increasing
5 yield in a crop by application of a synergistic herbicidal combination.

Another object of the present invention is to provide a method of improving the plant health by application of a synergistic herbicidal combination.

10 Some or all these and other objects of the invention can be achieved by way of the invention described hereinafter.

Summary of the invention:

15 A herbicidal combination comprising at least two synthetic auxin herbicides and at least one ALS inhibitor herbicide.

A method of controlling weeds at a locus, the method comprising applying a combination comprising at least two synthetic auxin herbicides and at least one
20 ALS inhibitor herbicide to the locus.

A composition comprising at least two synthetic auxin herbicides; at least one ALS inhibitor herbicide and at least one agrochemically acceptable excipient.

25 A method of controlling weeds at a locus, said method comprising applying a composition comprising at least two synthetic auxin herbicides; at least one ALS inhibitor herbicide and at least one agrochemically acceptable excipient.

Detailed Description of the invention:

The term herbicide, as used herein, shall mean an active ingredient that kills, controls or otherwise adversely modifies the growth of plants. As used herein, a herbicidally effective or vegetation controlling amount is an amount of active ingredient that causes a "herbicidal effect," i.e., an adversely modifying effect and includes deviations from natural development, killing, regulation, desiccation, or retardation. The terms "plants" and "vegetation" include, but are not limited to, germinant seeds, emerging seedlings, plants emerging from vegetative propagules, and established vegetation. The term "locus" as used herein shall denote the vicinity of a desired crop in which weed control, typically selective weed control is desired. The locus includes the vicinity of desired crop plants wherein the weed infestation has either emerged or is yet to emerge. The term crop shall include a multitude of desired crop plants or an individual crop plant growing at a locus.

The present inventors have found that the combination of specific herbicides belonging to classes of synthetic auxins and ALS inhibitor herbicides results in a synergistic control of undesirable plants, at the locus of the desirable crop plants.

Thus an embodiment of the present invention may be a herbicidal combination comprising at least two synthetic auxins and at least one ALS inhibitor herbicide.

The synthetic auxins of the present invention may be selected from (2,4-D); 2,4-DB; dicamba; chloramben; 2,4,5-T; clomeprop; dichlorprop; dichlorprop-P; MCPA;

MCPB; mecoprop; aminopyralid; clopyralid; fluroxypyr; halauxifen-methyl; picloram; triclopyr; aminocyclopyrachlor; quinclorac; quinmerac and their salts; and esters thereof.

- 5 In an embodiment, the preferred at least two synthetic auxins of the present invention are 2,4-D and picloram.

In an alternate embodiment, the preferred at least two synthetic auxins of the present invention may be halauxifen-methyl and picloram.

10

In an alternate embodiment, the preferred synthetic auxins of the present invention may be a combination of 2,4-D, picloram and triclopyr.

- ALS inhibitor herbicides cover a wide chemical class of compounds including
15 sulfonyleureas, imidazolinones, triazolopyrimidines, and pyrimidinyl thiobenzoates. The preferred class of compounds are sulfonyleurea herbicides.

- Sulfonyleurea herbicides are known in the art. Examples of such sulfonyleurea herbicides include rimsulfuron, metsulfuron, metsulfuron methyl, bensulfuron
20 methyl, ethametsulfuron, nicosulfuron, triasulfuron, primisulfuron, bensulfuron, chlorimuron, chlorimuron-ethyl, chlorsulfuron, sulfometuron, thifensulfuron, tribenuron, triflusaluron, clopyrasulfuron and pyrazosulfuron.

Thus, an aspect of the present invention may provide synergistic combinations of:

- 25 (a) at least two synthetic auxins selected from the group comprising (2,4-D), 2,4-DB, dicamba, chloramben, 2,4,5-T, clomeprop, dichlorprop, dichlorprop-P, MCPA, MCPB, mecoprop, aminopyralid, clopyralid,

fluroxypyr, halauxifen-methyl, picloram, triclopyr, aminocyclopyrachlor, quinclorac, quinmerac; and

(b) at least one ALS inhibitor herbicide selected from sulfonylurea herbicides.

5 Thus, in an embodiment, the sulfonylurea herbicide may be selected from the group consisting of amidosulfuron, azimsulfuron, bensulfuron, chlorimuron, cyclosulfamuron, ethoxysulfuron, flazasulfuron, flucetosulfuron, flupyrsulfuron, foramsulfuron, halosulfuron, imazosulfuron, mesosulfuron, metazosulfuron, methiopyrisulfuron, monosulfuron, nicosulfuron, orthosulfamuron, oxasulfuron, 10 primisulfuron, propyrisulfuron, pyrazosulfuron, rimsulfuron, sulfometuron, sulfosulfuron, trifloxysulfuron, zuomihuanglong, chlorsulfuron, cinosulfuron, ethametsulfuron, iodosulfuron, iofensulfuron, metsulfuron, prosulfuron, thifensulfuron, triasulfuron, tribenuron, triflusulfuron, and tritosulfuron.

15 The preferred sulfonylurea herbicide is metsulfuron methyl.

Therefore, an embodiment of the present invention may provide a combination comprising:

- (a) picloram;
- 20 (b) 2,4-D; and
- (c) Metsulfuron methyl.

Another aspect of the present invention may provide a composition.

25 Thus, an embodiment of the present invention may provide a composition comprising:

- (a) picloram;

- (b) 2,4D;
- (c) metsulfuron methyl; and
- (d) agrochemically acceptable adjuvants.

5 The combination may be applied to the locus of the weeds in an herbicidally effective amount. The selection of the appropriate effective amounts depends on the density of weed infestation, weather patterns, crop health and many other factors, which may be made conveniently by a person skilled in the art. The effective amounts of these herbicides in the synergistic combination of the
10 present invention is not particularly limiting.

In an embodiment, the combination of the present invention may be combined with at least one other active ingredient selected from the group consisting of herbicides, insecticides, fungicides, biological agents, plant growth activators,
15 fertilizers or combinations thereof.

Thus, in an embodiment, the combination of the present invention may be combined with another herbicide. Exemplary herbicides that may be combined with the combination of the present invention may be selected from, but not
20 limited to, herbicides belonging to classes such as ACCase inhibitors, , EPSP synthase inhibitors, auxin transport inhibitors, glutamate synthase inhibitors, HPPD inhibitors, lipid synthesis inhibitors, long chain fatty acid inhibitors, as well as herbicides with unknown modes of action.

25 In an embodiment, the total amount of synthetic auxins in the composition may typically be in the range of 0.1 to 99% by weight, preferably 0.2 to 90% by weight.

The total amount of sulfonylurea herbicide in the composition may be in the range of 0.1 to 99% by weight.

In an embodiment, the constituent herbicides of the combination of the present invention may be admixed in ratio of (1-80): (1-80): (1-80) of first synthetic auxin second synthetic auxin, and sulfonylurea herbicide respectively. Preferably, the ratio of the constituents of the present invention may be admixed in the ratio of (1-50): (1-50): (1-50) of first synthetic, auxin second synthetic auxin, and sulfonylurea herbicide respectively.

10

The herbicidal combination of the present invention maybe used to target weeds among the crops such corn, rice, wheat, barley, rye, oat, sorghum, cotton, soybean, peanut, buckwheat, beet, rapeseed, sunflower, sugar cane, tobacco, etc.; vegetables: solanaceous vegetables such as eggplant, tomato, pimento, pepper, potato, etc., cucurbit vegetables such as cucumber, pumpkin, zucchini, water melon, melon, squash, etc., cruciferous vegetables such as radish, white turnip, horseradish, kohlrabi, Chinese cabbage, cabbage, leaf mustard, broccoli, cauliflower, etc., asteraceous vegetables such as burdock, crown daisy, artichoke, lettuce, etc., liliaceous vegetables such as green onion, onion, garlic, and asparagus, ammiaceous vegetables such as carrot, parsley, celery, parsnip, etc., chenopodiaceous vegetables such as spinach, Swiss chard, etc., lamiaceous vegetables such as Perilla frutescens, mint, basil, etc, strawberry, sweet potato, Dioscorea japonica, colocasia, etc., flowers, foliage plants, turf grasses, pastures, fruits: pome fruits such apple, pear, quince, etc, stone fleshy fruits such as peach, plum, nectarine, Prunus mume, cherry fruit, apricot, prune, etc., citrus fruits such as orange, lemon, rime, grapefruit, etc., nuts such as chestnuts, walnuts, hazelnuts, almond, pistachio, cashew nuts, macadamia nuts, etc. berries such as blueberry,

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cranberry, blackberry, raspberry, etc., vines, kaki fruit, olive, plum, banana, oil palm, coffee, date palm, coconuts, etc. , trees other than fruit trees; tea, mulberry, flowering plant, trees such as ash, birch, dogwood, Eucalyptus, Ginkgo biloba, lilac, maple, Quercus, poplar, Judas tree, Liquidambar formosana, plane tree, zelkova, Japanese arborvitae, fir wood, hemlock, juniper, Pinus, Picea, and Taxus cuspidate, etc.

Thus, in another aspect, the present invention provides a method of controlling weeds at a locus, the method comprising applying a combination comprising at least two synthetic auxins and a sulfonylurea herbicide to the locus.

Thus, embodiments of the present invention may provide a method of controlling weeds at a locus, said method comprising application of synergistic combination of picloram; 2,4-D; and metsulfuron methyl and optionally a fourth active ingredient.

In an embodiment, the fourth active ingredient may selected from herbicide, insecticide, fungicide, biological agent, plant growth activator, fertilizers and combinations thereof.

The target weeds may be selected from Urticaceae weeds: *Urtica urens*; Polygonaceae weeds: *Polygonum convolvulus*, *Polygonum lapathifolium*, *Polygonum pensylvanicum*, *Polygonum persicaria*, *Polygonum longisetum*, *Polygonum aviculare*, *Polygonum arenastrum*, *Polygonum cuspidatum*, *Rumex japonicus*, *Rumex crispus*, *Rumex obtusifolius*, *Rumex acetosa*; Portulacaceae weeds: *Portulaca oleracea*; Caryophyllaceae weeds: *Stellaria media*, *Cerastium holosteoides*, *Cerastium glomeratum*, *Spergula arvensis*, *Silene gallica*;

Molluginaceae weeds: *Mollugo verticillata*; Chenopodiaceae weeds:
Chenopodium album, *Chenopodium ambrosioides*, *Kochia scoparia*, *Salsola kali*,
Atriplex spp.; Amaranthaceae weeds: *Amaranthus retroflexus*, *Amaranthus viridis*,
Amaranthus lividus, *Amaranthus spinosus*, *Amaranthus hybridus*, *Amaranthus*
 5 *palmeri*, *Amaranthus rudis*, *Amaranthus patulus*, *Amaranthus tuberculatus*,
Amaranthus blitoides, *Amaranthus deflexus*, *Amaranthus quitensis*, *Alternanthera*
philoxeroides, *Alternanthera sessilis*, *Alternanthera tenella*; Papaveraceae weeds:
Papaver rhoeas, *Argemone Mexicana*; Brassicaceae weeds: *Raphanus*
raphanistrum, *Raphanus sativus*, *Sinapis arvensis*, *Capsella bursa-pastoris*,
 10 *Brassica juncea*, *Brassica campestris*, *Descurainia pinnata*, *Rorippa islandica*,
Rorippa sylvestris, *Thlaspi arvense*, *Myagrum rugosum*, *Lepidium virginicum*,
Coronopus didymus; Capparaceae weeds: *Cleome affinis*; Fabaceae weeds:
Aeschynomene indica, *Aeschynomene rudis*, *Sesbania exaltata*, *Cassia obtusifolia*,
Cassia occidentalis, *Desmodium tortuosum*, *Desmodium adscendens*, *Trifolium*
 15 *repens*, *Pueraria lobata*, *Vicia angustifolia*, *Indigofera hirsuta*, *Indigofera*
truxillensis, *Vigna sinensis*; Oxalidaceae weeds: *Oxalis corniculata*, *Oxalis stricta*,
Oxalis oxypetala; Geraniaceae weeds: *Geranium carolinense*, *Erodium cicutarium*;
 Euphorbiaceae weeds: *Euphorbia helioscopia*, *Euphorbia maculata*, *Euphorbia*
humistrata, *Euphorbia esula*, *Euphorbia heterophylla*, *Euphorbia brasiliensis*,
 20 *Acalypha australis*, *Croton glandulosus*, *Croton lobatus*, *Phyllanthus*
corcovadensis, *Ricinus communis*; Malvaceae weeds: *Abutilon theophrasti*, *Sida*
rhombifolia, *Sida cordifolia*, *Sida spinosa*, *Sida glaziovii*, *Sida santaremnensis*,
Hibiscus trionum, *Anoda cristata*, *Malvastrum coromandelianum*
 Sterculiaceae weeds: *Waltheria indica*; Violaceae weeds: *Viola arvensis*, *Viola*
 25 *tricolor*; Cucurbitaceae weeds: *Sicyos angulatus*, *Echinocystis lobata*, *Momordica*
charantia; Lythraceae weeds: *Lythrum salicaria*; Apiaceae weeds: *Hydrocotyle*
sibthorpioides; Sapindaceae weeds: *Cardiospermum halicacabum*; Primulaceae

weeds: *Anagallis arvensis*; Asclepiadaceae weeds: *Asclepias syriaca*, *Ampelamus albidus*; Rubiaceae weeds: *Galium aparine*, *Galium spurium* var. *echinospermon*, *Spermacoce latifolia*, *Richardia brasiliensis*, *Borreria alata*; Convolvulaceae weeds: *Ipomoea nil*, *Ipomoea hederacea*, *Ipomoea purpurea*, *Ipomoea hederacea* var. *integriuscula*, *Ipomoea lacunosa*, *Ipomoea triloba*, *Ipomoea acuminata*, *Ipomoea hederifolia*, *Ipomoea coccinea*, *Ipomoea quamoclit*, *Ipomoea grandifolia*, *Ipomoea aristolochiaefolia*, *Ipomoea cairica*, *Convolvulus arvensis*, *Calystegia hederacea*, *Calystegia japonica*, *Merremia hedeacea*, *Merremia aegyptia*, *Merremia cissoides*, *Jacquemontia tamnifolia*; Boraginaceae weeds: *Myosotis arvensis*; Lamiaceae weeds: *Lamium purpureum*, *Lamium amplexicaule*, *Leonotis nepetaefolia*, *Hyptis suaveolens*, *Hyptis lophanta*, *Leonurus sibiricus*, *Stachys arvensis*; Solanaceae weeds: *Datura stramonium*, *Solanum nigrum*, *Solanum americanum*, *Solanum ptycanthum*, *Solanum sarrachoides*, *Solanum rostratum*, *Solanum aculeatissimum*, *Solanum sisymbriifolium*, *Solanum carolinense*, *Physalis angulata*, *Physalis subglabrata*, *Nicandra physaloides*; Scrophulariaceae weeds: *Veronica hederaefolia*, *Veronica persica*, *Veronica arvensis*; Plantaginaceae weeds: *Plantago asiatica*; Asteraceae weeds: *Xanthium pensylvanicum*, *Xanthium occidentale*, *Helianthus annuus*, *Matricaria chamomilla*, *Matricaria perforata*, *Chrysanthemum segetum*, *Matricaria matricarioides*, *Artemisia princeps*, *Artemisia vulgaris*, *Artemisia verlotorum*, *solidago altissima*, *Taraxacum officinale*, *Galinsoga ciliata*, *Galinsoga parviflora*, *Senecio vulgaris*, *Senecio brasiliensis*, *Senecio grisebachii*, *Conyza bonariensis*, *Conyza canadensis*, *Ambrosia artemisiaefolia*, *Ambrosia trifida*, *Bidens pilosa*, *Bidens frondosa*, *Bidens subalternans*, *Cirsium arvense*, *Cirsium vulgare*, *Silybum marianum*, *Carduus nutans*, *Lactuca serriola*, *Sonchus oleraceus*, *Sonchus asper*, *Wedelia glauca*, *Melampodium perfoliatum*, *Emilia sonchifolia*, *Tagetes minuta*, *Blainvillea latifolia*, *Tridax procumbens*, *Porophyllum ruderales*, *Acanthospermum australe*,

Acanthospermum hispidum, Cardiospermum halicacabum, Ageratum
 conyzoides, Eupatorium perfoliatum, Eclipta alba, Erechites hieracifolia,
 Gamochaeta spicata, Gnaphalium spicatum, Jaegeria hirta, Parthenium
 hysterophorus, Siegesbeckia orientalis, Soliva sessilis; Liliaceae weeds: Allium
 5 canadense, Allium vineale; Commelinaceae weeds: Commelina communis;
 Commelina bengharensis, Commelina erecta; Poaceae weeds: Echinochloa crus-
 galli, Setaria viridis, Setaria faberi, Setaria glauca, Setaria geniculata, Digitaria
 ciliaris, Digitaria sanguinalis, Digitaria horizontalis, Digitaria insularis, Eleusine
 indica, Poa annua, Alopecurus aequalis, Alopecurus myosuroides, Avena fatua,
 10 Sorghum halepense, Sorghum vulgare, Agropyron repens, Lolium multiflorum,
 Lolium perenne, Lolium rigidum, Bromus secalinus, Bromus tectorum, Hordeum
 jubatum, Aegilops cylindrica, Phalaris arundinacea, Phalaris minor, Apera spica-
 venti, Panicum dichotomiflorum, Panicum texanum, Panicum maximum,
 Brachiaria platyphylla, Brachiaria ruziziensis, Brachiaria plantaginea, Brachiaria
 15 decumbens, Brachiaria brizantha, Brachiaria humidicola, Cenchrus echinatus,
 Cenchrus pauciflorus, Eriochloa villosa, Pennisetum setosum, Chloris gayana,
 Eragrostis pilosa, Rhynchelitrum repens, Dactyloctenium aegyptium, Ischaemum
 rugosum, Oryza sativa, Paspalum notatum, Paspalum maritimum, Pennisetum
 clandestinum, Pennisetum setosum, Rottboellia cochinchinensis; Cyperaceae
 20 weeds: Cyperus microiria, Cyperus iria, Cyperus odoratus, Cyperus rotundus,
 Cyperus esculentus, Kyllinga gracillima
 Equisetaceae weeds: Equisetum arvense, Equisetum palustre, and the like

In an embodiment, the individual components of the combination of the present
 25 invention may be applied to the locus either simultaneously or sequentially, such
 that at least two auxins and at least one sulfonylurea herbicide may be applied in
 a tank mix or as a pre-mixed composition.

In an embodiment, combination of the present invention may be applied either pre or post emergent. The advantage of the combination is surprisingly good residual effects, when applied in pre-emergent as well as quick knockdown when
5 applied post emergent leading to quick control of weeds.

The method of control of the present invention may be carried out by spraying the suggested tank mixes, or the individual herbicides may be formulated as a kit-of-parts containing various components that may be mixed as instructed prior
10 to spraying.

In an embodiment the components of the present invention may be packaged such that at least two auxins and at least one sulfonyleurea herbicide may be packaged separately and then tank mixed before the spraying.

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In another embodiment the components of the present invention may be packaged such that picloram, 2,4-D and metsulfuron methyl may be packaged separately, whereas other additives are packaged separately, such that the two maybe tank mixed at the time of spraying.

20

In another embodiment the components of the present invention may be packaged as composition such that at least two synthetic auxin herbicide and at least one sulfonyleurea herbicide may be formulated into one composition and other additives are packaged separately, such that the two maybe tank mixed at
25 the time of spraying.

Therefore, in another aspect, the present invention may provide compositions comprising at least two synthetic auxin herbicides, at least one sulfonylurea herbicide and at least one agrochemically acceptable excipient.

- 5 In an embodiment, the present invention may provide compositions comprising at least two synthetic auxins selected from picloram and 2,4-D and at least a sulfonylurea herbicide selected from metsulfuron methyl.

10 In an embodiment, the composition of the present invention may contain agriculturally acceptable adjuvants, carriers, diluents, emulsifiers, fillers, anti-foaming agents, thickening agents, anti-freezing agents, freezing agents etc. The compositions may be either solid or liquids. They can be solids, such as, for example, dusts, granules, water-dispersible granules, microcapsules or wettable powders, or liquids, such as, for example, emulsifiable concentrates, solutions, 15 emulsions or suspensions, ZC formulations. They can also be provided as a pre-mix or tank mixes.

Suitable agricultural adjuvants and carriers may include, but are not limited to, crop oil concentrates; methylated seed oils, emulsified methylated seed oil, 20 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 (C₁₂-C₁₆) ethoxylate; di-sec-butylphenol EO-PO block copolymer; polysiloxane-methyl cap; nonylphenol ethoxylate, urea ammonium nitrate; tridecyl alcohol 25 (synthetic) ethoxylate (8EO); tallow amine ethoxylate ; PEG(400) dioleate-99, alkyl sulfates, such as diethanolammonium lauryl sulfate; alkylarylsulfonate salts, such as calcium dodecylbenzenesulfonate; alkylphenol-alkylene oxide addition

products, such as nonylphenol-C₁₈ ethoxylate; alcohol-alkylene oxide addition products, such as tridecyl alcohol-C₁₆ ethoxylate; soaps, such as sodium stearate; alkyl-naphthalene-sulfonate salts, such as sodium dibutylnaphthalenesulfonate; dialkyl esters of sulfosuccinate salts, such as sodium di(2-ethylhexyl)sulfosuccinate; 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, , methyl esters and the like.

Suitable liquid carriers that may be employed in a composition of the present invention may include water or 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, rapeseed 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. Organic solvents include, but are not limited to toluene, xylene, petroleum naphtha, crop oil, acetone, methyl ethyl ketone, cyclohexanone, trichloroethylene, perchloroethylene, 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.

- 5 Solid carriers that may be employed in the compositions of the present invention may include but are not limited to attapulgite, pyrophyllite clay, silica, kaolin clay, kieselguhr, chalk, diatomaceous earth, lime, calcium carbonate, bentonite clay, Fuller's earth, talc, cottonseed hulls, wheat flour, soybean flour, pumice, wood flour, walnut shell flour, lignin, cellulose etc.

10

Suitable stabilising agents such as buffers such ammonium phosphate dibasic, ammonium sulfate, ammonium, potassium dibasic phosphate, and the like, other stabilizers such as casein, tragacanth, carboxymethyl cellulose (CMC), polyvinyl alcohol (PVA) and the like.

15

Thus, in another aspect, the present invention provides a method of controlling weeds at a locus, said method comprising applying a composition comprising at least two synthetic auxins, at least one sulfonylurea herbicide and at least one agrochemically acceptable excipient.

20

- Surprisingly, it has been found by the present inventors that at least two synthetic auxins and at least a sulfonylurea herbicide, when applied individually, was ineffective in the control of weeds, but demonstrated excellent synergistic control on weeds when applied together. The combination controlled the weed both pre and post emergently. The combination of at least two synthetic auxins and at least a sulfonylurea herbicide synergistically controlled broadleaf weeds, sedges, and grasses a particular locus. The current invention therefore provides advantageous
- 25

methods of controlling weeds both pre and post emergently. The present method also provides a broader spectrum of controlling weeds that helps in resistance management, thus preventing the weed from becoming resistant to either of the herbicides whilst providing a broader spectrum of control at lower use rates.

5

The invention shall now be described with reference to the following specific examples. It should be noted that the example(s) appended below illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the present invention.

10

EXAMPLES:

FORMULATIONS STUDIES:

S. No.	Ingredients	Amount (gms/lit, %)	Generic Name	Function/Role of ingredients
1	Picloram ácid tech	96,00	Picloram ácid tech	Active Ingredient
2	2,4 D ácid tech	318,00	2,4 D ácid tech	Active Ingredient
3	Metsulfuron Methyl tech	45,00	Metsulfuron Methyl tech	Active Ingredient
4	Ammonium phosphate dibasic	451,00	Ammonium phosphate dibasic	Neutralizing agent
5	Sodium dodecylbenzene sulfonate	30,0	Agnique 46 NP	Wetting agent
6	Sulphonated aromatic polymer, sodium salt	30,0	Morwet D425	Dispersant agent

7	Croscarmellose sodium	30,0	Solutab	binder
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The above formulation was also found to solve the technical problem of making metsulfuron molecule compatible with 2,4-D acid and Picloram in the same formulation. Hitherto, all commercially available products of 2,4-D and picloram were in soluble liquid i.e. SL formulation, which entails the use of water as the solvent. However, metsulfuron-methyl degrades rapidly by hydrolysis in the protonic media e.g. in an aqueous solution (DT50/25°C=4.7d, pesticide manual), which makes it incompatible in liquid formulations, mostly in SL type formulation in which water is used as solvent. This posed a formulation problem as 2,4D-DMA and Picloram-DMA are conventionally formulated in liquid water-based formulations. Further, in order to render 2,4D- acid and picloram soluble in water, they need to be neutralized by an organic base, producing a soluble salt in water. Dimethylammonium is the most common alkali used to neutralize these two acid and insoluble active ingredients in water.

Accordingly, the present invention provides a solid formulation comprising 2,4-D, picloram and metsulfuron-methyl.

Preferably, the solid formulation is a wettable granule (WG) formulation comprising 2,4-D, picloram and metsulfuron-methyl.

Thus, presenting these active ingredients in a solid formulation avoids the contact of metsulfuron-methyl with the aqueous media and thus avoids its degradation. In order to make the WG formulation possible, 2,4-D acid and picloram were neutralized in an unexpected manner according to the present invention.

Thus, according to the present invention, 2,4-D-acid and picloram were *in situ* neutralized in the presence of an alkali salt.

In an embodiment, the preferred alkali salt was dibasic ammonium phosphate.

Thus, the alkali salt was mixed into the formulation together with Metsulfuron, 2,4-D acid, and Picloram acid, dispersing/wetting agents and other inerts. All the ingredients together were milled into a jet mill up to the particle size being reduced to $d_{90} < 10$ microns. To make the dough from this milled powder, a rigorous control of adding minimum water with vigorous mixing process is required. Extrusion of the dough was done with a conventional screw extruder, and granules were dried in the sequence of process until reach moisture contain less than 2%. Fluid bed dryer at 54°C is used to remove water from granules.

- 10 These wettable granule formulation (WG) were applied into the crops after being diluted into the spray solution.

It was found that the alkali salt ammonium phosphate dibasic reacted with 2,4-D acid (solubility= 311 mg/l) and Picloram acid (solubility= 560 mg/l), producing 2,4-D ammonium salt and Picloram ammonium salt, thereby increasing solubility of both active ingredients into this spray solution.

It was concluded that one of the advantages of the present invention was to render 2,4-D and picloram acids to corresponding salts to make those active ingredients soluble, which resulted into good and uniform application in crops. In the absence of the alkali salts of the invention, the insoluble 2,4-D and picloram acid active ingredients did not have good biological performance and blocked nozzles during spraying.

The formulations of the present invention were then subjected to the efficacy studies.

SYNERGY STUDIES

Studies were conducted to compare the weed controlling activity of the combination of at least two synthetic auxins and at least one sulfonylurea herbicide and compared the observed efficacy with the "expected" efficacy. Any difference between the observed and "expected" efficacy could be attributed to synergy between the compounds. The synthetic auxins were picloram and 2,4-D, whereas, the sulfonylurea was metsulfuron methyl. The expected efficacy of the combination was calculated using the well-established Colby method.

In the Colby method, the expected (or predicted) response of a combination of herbicides is calculated by taking the product of the observed response for each individual component of the combination when applied alone divided by 100 and subtracting this value from the sum of the observed response for each component when applied alone. An unexpected enhancement in efficacy of the combination is then determined by comparing the observed response of the combination to the expected (or predicted) response as calculated from the observed response of each individual component alone. If the observed response of the combination is greater than the expected (or predicted) response, or stated conversely, if the difference between the observed and expected response is greater than zero, then the combination is said to be synergistic or unexpectedly effective. (Colby, S. R., Weeds, 1967(15), p. 20-22) The Colby method requires only a single dose of each herbicide applied alone and the mixture of both doses. The formula used to calculate the expected efficacy (EE) which was compared with the observed efficacy (OE) to determine the efficacy of the present invention is explained hereinbelow:

25

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

The weed control activity of the individual herbicides of the invention and their combinations were evaluated on weeds such as *Ipomea grandifolia* and *Bidens pilosa* in cotton was evaluated. The trial was carried out in Randomized Complete Block (RCB) method, all field trials were conducted using this method. Each trial were replicated four times and conducted under GEP guidelines. Application volumes were varied for each mixture. Such field trials were carried out at various locations so as to generate independent data, the locations were chosen randomly across Brazil. Picloram, 2,4-D acid and 2,4-D sodium and Metsulfuron methyl were sprayed according to their recommended dosage.

The following formula was used to calculate the expected activity of mixtures containing three active ingredients A, B and C:

$$\text{Expected (E)} = A + B + C - \frac{(AB+AC+BC)}{100} + \frac{ABC}{10,000}$$

Where

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.

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

The herbicide tank mix combinations, application rates, plant species tested, and results are given in the following examples:

Examples 1: 2,4-D, Picloram, metsulfuron methyl:

Field trials were carried out to test the synergy of the combination 2,4-D, Picloram, and metsulfuron methyl. The field trials were carried out at various locations in Brazil. The percentage efficacy was calculated after 60 days of applications. The target weed was *Ipomea grandifolia* and *Bidens pilosa* and the results are recorded in the table below:

Table 1:

Dose		% Weed control					
		7DAA		14DAA		21DAA	
Active	Rate Unit (g/ml per hectare)	Expected	Actual	Expected	Actual	Expected	Actual
Untreated Check			0.00		0.00		0.00
2,4 -D	48.00	-	23.3		22.3		30
Picloram	159	-	21.7		22.7		27.7
Metsulfuron methyl	22.5	-	8.7		20.7		22
2,4D + Picloram + Metsulfuron methyl	48 + 159 + 22.5	45.2	55.0	52.4	94.7	60.52	98.7
Observed efficacy	- Expected	9.8		42.3		38.18	

In the Colby method, the expected (or predicted) response of a combination of herbicides is calculated by taking the product of the observed response for each individual component of the combination when applied alone divided by 100 and subtracting this value from the sum of the observed response for each component when applied alone. An unexpected enhancement in efficacy of the combination is then determined by comparing the observed response of

the combination to the expected (or predicted) response as calculated from the observed response of each individual component alone. If the observed response of the combination is greater than the expected (or predicted) response, or stated conversely, if the difference between the observed and expected response is greater than zero, then the combination is said to be synergistic or unexpectedly effective.

Thus, when the combination of the present invention was analyzed using this method, it demonstrated an observed – expected value of greater than zero which is indicative of an unexpected efficacy. The basis of demonstration of unexpected efficacy by comparison with the Colby formula is that herbicide (A) tested alone would kill a proportion of the target weeds and leave the remaining portion (a%) as survivors. Similarly, herbicide B tested alone will leave (b%) as survivors, and herbicide C tested alone will leave (c%) survivors. When combined, A+B+C will, act independently on the target weed (if unexpected activity is absent); component A leaving a% survivors, which survivors will be controlled by component B and the final survivors being controlled by component C; which has an overall effect of $a\% \cdot b\% \cdot c\% \cdot 100$. Subsequently, if the percent control is greater than that predicted by the Colby formula or stated conversely, if the difference between the observed control and the expected control is greater than zero; then unexpected enhancement in activity is acknowledged. The degree to which the difference is greater than zero is not itself critical as long as it is greater than zero; however greater the difference, more significant is the enhancement or the unexpectedness in weed control.

Further field trials were carried out to test the synergy of the combination 2,4-D, picloram and the sulfonylurea herbicide metsulfuron methyl. The field trials were carried out at various locations in Brazil on cotton crops. The percentage efficacy

was calculated after 21 days of applications. The target weed was *Ipomea grandifolia* and *Bidens pilosa* and the results are recorded in the table below:

Table 2:

Dose		% Weed control					
		7DAA		14DAA		21DAA	
Active	Rate Unit	Expected	Actual	Expected	Actual	Expected	Actual
Untreated Check			0.00		0.00		0.00
2,4-D	0,2		23.0		22.3		30
Picloram	0,24		21		22.7		27
Metsulfuron methyl	0,038		8.7		20		32
2,4-D + Picloram + Metsulfuron methyl	0,2+ 0,24+ 0,038	42.5	51	52.4	90.7	60.52	95.7
Observed Expected efficacy	-	8.5		38.3		35.18	

- 5 The results in tables 1 and 2 clearly demonstrate a synergy when the combination of 2,4-D, Picloram and, metsulfuron methyl was used to control *Ipomea grandifolia* and *Bidens pilosa*. No phytotoxicity was observed in any of the trials.

- 10 While the foregoing written description of the invention enables one of ordinary skill to make and use what is considered presently to be the best mode thereof, those of ordinary skill will understand and appreciate the existence of variations, combinations, and equivalents of the specific embodiment, method, and examples herein. The invention should therefore not be limited by the above

described embodiment, method, and examples, but by all embodiments and methods within the scope and spirit of the invention.

5 Dated this the 8th day of August 2017



Dr. Sanchita Ganguli
Of S. MAJUMDAR & CO.
Applicant's Agent

10

FORM 1 THE PATENTS ACT, 1970 (39 of 1970) and The Patents Rules, 2003 APPLICATION FOR GRANT OF PATENT [See section 7, 54 & 135 and sub-rule (1) of rule 20]	(FOR OFFICE USE ONLY)
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	Application No :		
	Filing Date :		
	Amount of Fee Paid :		
	CBR No :		
	Signature :		
1. APPLICANT'S REFERENCE / IDENTIFICATION NO. (AS ALLOTTED BY OFFICE)			
2. TYPE OF APPLICATION [Please tick (√) at the appropriate category]			
Ordinary (√)		Convention ()	PCT-NP ()
Divisional ()	Patent of Addition ()	Divisional ()	Patent of Addition ()

3A. APPLICANT(S)

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3B. CATEGORY OF APPLICANT [Please tick (√) at the appropriate category]

Natural Person ()	Other than Natural Person		
	Small Entity ()	Startup ()	Others (√)

4. INVENTOR(S) [Please tick (√) at the appropriate category]

Are all the inventor(s) same as the applicant(s) named above ?	YES ()	NO (√)
--	---------	--------

If "No", furnish the details of the inventor(s)

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				Pin code	
SHROFF, Vikram Rajnikant	A British Citizen	Dubai U.A.E.	-	House No.	206, Swiss Tower, Cluster Y
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				City	
				State	
				Country	Dubai - U.A.E.
				Pin code	

5. TITLE OF THE INVENTION: SYNERGISTIC HERBICIDAL COMBINATIONS

6. AUTHORISED REGISTERED PATENT AGENT(S)	IN/PA No.	625
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8. IN CASE OF APPLICATION CLAIMING PRIORITY OF APPLICATION FILED IN CONVENTION COUNTRY, PARTICULARS OF CONVENTION APPLICATION

COUNTRY	APPLICATION NUMBER	FILING DATE	NAME OF THE APPLICANT	TITLE OF THE INVENTION	IPR (as classified in the convention country)

9. IN CASE OF PCT NATIONAL PHASE APPLICATION, PARTICULARS OF INTERNATIONAL APPLICATION FILED UNDER PATENT COOPERATION TREATY (PCT)

International application number	International filing date as allotted by the receiving office

10. IN CASE OF DIVISIONAL APPLICATION FILED UNDER SECTION 16, PARTICULARS OF ORIGINAL (FIRST) APPLICATION

Original (first) application number	Date of filing of Original (first) application

11. IN CASE OF PATENT OF ADDITION FILED UNDER SECTION 54, PARTICULARS OF MAIN APPLICATION OR PATENT

Main application / patent Number	Date of filing of main application

12. DECLARATIONS

(i) Declaration by the inventor(s)

(In case the applicant is an assignee : the inventor(s) may sign herein below or the applicant may upload the assignment or enclose the assignment with this application for patent or send the assignment by post/electronic transmission duly authenticated within the prescribed period).

We, the above named inventor(s) are the true & first inventor(s) for this invention and declare that the applicant(s) herein are our assignee or legal representative.

(a) Date 22 September 2017 Alexandre Leite Brito
(b) Signature(s) of the inventor(s):
(c) Name of the inventor: **ALEXANDRE LEITE BRITO**

(a) Date 01 September 2017
(b) Signature(s) of the inventor(s): Bruna Mariele de Almeida
(c) Name of the inventor: **BRUNA MARIELE DE ALMEIDA**

(a) Date 01 September 2017
(b) Signature(s) of the inventor(s): [Signature]
(c) Name of the inventor: **FERDINANDO MARCOS LIMA SILVA**

(a) Date Joaquim Ribeiro da Cunha - 01 September 2017
(b) Signature(s) of the inventor(s):
(c) Name of the inventor: **JOAQUIM RIBEIRO DA CUNHA**

(a) Date [Signature]
(b) Signature(s) of the inventor(s):
(c) Name of the inventor: **LUCIANO ZANOTTO HOHMANN**

(a) Date 14 September 2017
(b) Signature(s) of the inventor(s): Natalia Gonçalves
(c) Name of the inventor: **NATALIA GONÇALVES**

(a) Date 06 September 2017
(b) Signature(s) of the inventor(s): [Signature]
(c) Name of the inventor: **SERGIO TADEU DECARO JUNIOR**

(a) Date 14.09.2017 [Signature]
(b) Signature(s) of the inventor(s):
(c) Name of the inventor: **SHROFF, Jaidev Rajnikant**

(a) Date [Signature] 01.09.2017
(b) Signature(s) of the inventor(s):
(c) Name of the inventor: **SHROFF, Vikram Rajnikant**

(ii) Declaration by the applicant(s) in the convention country

~~(In case the applicant in India is different than the applicant in the convention country, the applicant in the convention country may sign herein below or applicant in India may upload the assignment from the applicant in the convention country or enclose the said assignment with this application for patent or send the assignment by post/electronic transmission duly authenticated within the prescribed period)~~

I/We, the applicant(s) in the convention country declare that the applicant(s) herein is/are my/our assignee or legal representative

(a) Date _____

(b) Signature(s) _____

(c) Name(s) of the Signatory: _____

(iii) Declaration by the applicant(s):

I/We, the applicant(s) hereby declare(s) that :

- ☒ We are in possession of the above-mentioned invention
- ☒ The provisional specification relating to the invention is filed with this application.
- ☒ The invention as disclosed in the specification uses the biological material from India and the necessary permission from the competent authority shall be submitted by us before the grant of patent to us.
- ☒ There is no lawful ground of objection(s) to the grant of the Patent to us.
- ☒ We are the true & first inventor(s).
- ☒ We are the assignee or legal representative of true & first inventor(s).
- ☒ The application or each of the applications, particulars of which are given in Paragraph-8, was the first application in convention country/countries in respect of my/our invention.
- ☒ I/We claim the priority from the above mentioned application(s) filed in convention country/ countries and state that no application for protection in respect of the invention had been made in a convention country before that date by me/us or by any person from which I/we derive the title.
- ☒ My/Our application in India is based on international application under Patent Cooperation Treaty (PCT) as mentioned in Paragraph-9.
- ☒ The application is divided out of my/our application particulars of which is given in Para-10 and pray that this application may be treated as deemed to have been filed on (DD/MM/YYYY) under Section 16 of the Act.
- ☒ The said invention is an improvement in or modification of the invention particulars of which are given in Paragraph-11.

13. FOLLOWING ARE THE ATTACHMENTS WITH THE APPLICATION

(a) Form 2

Item	Details	Fee	Remarks
Provisional specification)#	No. of pages (27)		
No. of claims	No. of claims and no. of pages		

Abstract	No. of pages		
No. of Drawing(s)	No. of drawings () and No. of pages ()		

In case of a complete specification, if the applicant desires to adopt the drawings filed with his provisional specification as the drawings or part of the drawings for the complete specification under rule 13(4), the number of such pages filed with the provisional specification are required to be mentioned here.

(b)

(a) Form -2 with provisional specification (2 copies). No. of pages 27

(b) Statement and undertaking on Form 3

(c) General Power of Attorney in our favour.

(d) Fee for excess pages exceeding 30 = NIL

(e) Fee for application = Rs. 8,000.00

Fee Rs. 8000/-

We hereby declare that to the best of our knowledge, information and belief the fact and matters stated herein are correct and we request that a patent may be granted to us for the said invention.

Dated this 8th day of August 2017

S. Ganguli
Dr. Sanchita Ganguli
of S. MAJUMDAR & CO.
Applicants' Agent

To
The Controller of Patents
The Patent Office,
At Kolkata

Note:-

- * Repeat boxes in case of more than one entry.
- * To be signed by the applicant(s) or by authorized registered patent agent otherwise where mentioned.
- * Tick (✓)/cross (x) whichever is applicable/not applicable in declaration in paragraph - 12.
- * Name of the inventor and applicant should be given in full, family name in the beginning.
- * Strike out the portion which is/are not applicable.
- * For fee: See First Schedule