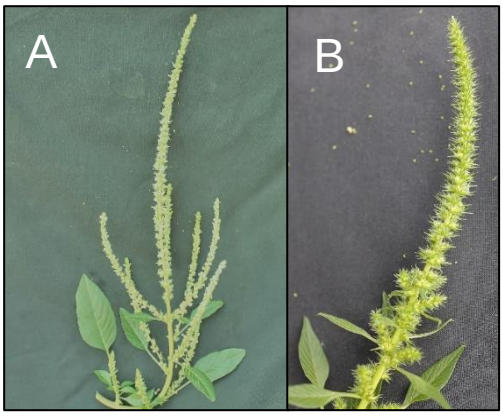
PLAN FOR ERADICATION OF THE PALMER AMARANTH (*AMARANTHUS PALMERI)* IN THE REPUBLIC OF SOUTH AFRICA

March 2019



Male and female inflorescence of *Amaranthus palmeri*
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Background

During late 2017, the first case of the Palmer amaranth (*Amaranthus palmeri*) weed species was reported in a farm at the Douglas district in the Republic of South Africa. This Palmer amaranth population established itself on certain parts of the farm mainly in cotton as well as in maize and lucerne fields. More recently plants believed to be Palmer amaranth were discovered 20 km south of the farm in Douglas district and on a farm in the Prieska district. These plants were submitted for DNA sequencing to ascertain whether they are Palmer amaranth. The source of the introduction of this exotic Amaranthus species into these areas is unknown. It has established itself in parts over at least 1,200 hectares of crop fields on the farm in the Douglas district while the extent of infestation at the other two localities is yet to be determined. Globally, Palmer amaranth is known to be resistant to eight herbicide sites of action (SoAs) groups. Preliminary herbicide resistance assessment conducted so far on Palmer amaranth population collected from the cotton field in Douglas district has shown that this population is resistant to all the three herbicides tested, representing 3 different SoAs namely glyphosate (Group G), Chlorimuron (Group B) and Mesotrione (Group F2). Additional testing for potential resistance of this Palmer amaranth population against herbicides representing other SoAs is being planned.

Careful selection of effective herbicides and non-chemical control measures will be required to eradicate the Palmer amaranth population. Measures to eradicate the current populations and prevent further spread of Palmer amaranth in the current production season and preparation for the following planting season are provided in this plan. It is very important for crop farmers to implement these measures immediately to prevent a catastrophic invasion of this weed in the larger crop farming areas of South Africa.

Threat to crop farming

The Palmer amaranth is an highly competitive weed species with rapid growth rate (grows >6 cm per day), germinates throughout much of the growing season, capable to produce an abundance of offspring (up to 600,000 seeds per plant), its genetic diversity and ability to tolerate adverse conditions are some of the characteristics that contributed to this weed species becoming such a dominant and difficult-to-control weed. Once the Palmer amaranth has infested, it requires a multi-year weed control management plan due to its ability to stay in the soil seedbank for approximately 3-4 years. In the United States, Palmer amaranth is reported to be resistant to eight different SoAs and requires meticulous planning to manage it. When uncontrolled, Palmer amaranth infestation can result in significant yield losses up to 94%. In addition, it is likely to hybridize with other *Amaranthus* species that are native to South Africa at a low frequency and has potential to transfer its herbicide resistance characteristics over a wide spectrum of *Amaranthus* species. It has the potential to impede the export of grain products to other countries if such countries implement a phytosanitary trade barrier to protect their own agricultural interests.

Management

Palmer amaranth is not classified as an invasive species in South Africa under the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) hence there is currently no legislative tools to enforce the eradication of this species by government agencies (Department of Agriculture, Forestry and Fisheries, DAFF). CropLife SA in collaboration with its Herbicide Resistance Action Committee (HRAC) members, agrochemical suppliers, academics (notably Prof Charlie Reinhardt and Prof Juan Vorster), cooperatives (GWK), the Agriculture Research Council (ARC) and Grain SA have collectively drafted this emergency mitigation plan to manage and contain further spread of the Palmer amaranth species and possible hybrids in the already affected areas. It is prudent for all affected farmers to implement the proposed control measures immediately to prevent this species from seriously damaging crop production in South Africa. Agrochemical agents must ensure that their clients use herbicides that are effective against this species and apply it according to the label instructions.

EMERGENCY WEED ERADICATION PROTOCOL

1. General principles.

a. This will be a long-term effort lasting 4 to 5 years.

b. There needs to be zero tolerance for additional Palmer amaranth seed and no plants shall be allowed to set seed.

c. There needs to be zero tolerance for Palmer amaranth plants to survive.

d. There needs to be an intensity around management and containment; eradicate and kill plants on site and do not allow them to spread further.

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e. Treat all equipment that could possibly have been exposed to Palmer amaranth as if it is contaminated with seed! Sanitize properly before moving it.

f. Do not move soil around because you will be moving seed. Sanitize shoes, clothing, vehicle tyres and all equipment before moving these items around the farm and off the farm.

Regard all *Amaranthus* plants on farms in the Orange River region as probably *A. palmeri* or hybrids of *A. palmeri* and other *Amaranthus* species. Eradicate all *Amaranthus* plants irrespective of whether they are *palmeri* or not.

USE ALL AVAILABLE METHODS OF WEED CONTROL IN AN INTEGRATED WEED MANAGEMENT SYSTEM.

- ✓ Growers must set up and maintain a scouting programme on all farms where the species may have established itself.
- ✓ Intensify control efforts in all drainage lines on farms.
- ✓ Do follow-up herbicide treatments for any re-growth, re-sprouting or newly germinating *Amaranthus* plants irrespective of species.
- ✓ Ensure to apply effective residual herbicides in addition to post-emergence application.
- ✓ Do not plant broad-leaved crops as the herbicides required for the control of this weed will damage broad-leaved crops.

2. Assess the infestation.

Step 1: Aerial assessment of infestation on farm and one-kilometre radius around the farm (this is optional and is not strictly required to assess the level of infestation; visual assessment is a possible alternative) to determine which control option must be implemented.

a. Action 1: Contract a licensed drone operator to take aerial photographs in colour, IR or UV of the infected area and adjacent area.
b. Action 2: Conduct an analysis of the photographs and categorise the infested areas:

   i. Total to 80% infestation probably demands a desiccate and burn option.
   ii. 80% to 50% infestation probably demands a desiccate and burn option.
   iii. 50% to 30% infestation probably requires a hand weeding and burn option.
   iv. Below 30% infestation demands a hand weeding and burn option.

3. Design the eradication programme.

Design a phased integrated weed control programme using mechanical removal, herbicide application and cultivation, namely:

a. Phase 1: Do an immediate removal of the existing infestation by implementing one of two options: (a) use a desiccant herbicide and burn afterwards or (b) pull the weeds out by hand and burn outside the field in a shallow trench as left-over seed may be washed away during water run-off. Check the site twice a week for possible sprouting of surviving *Amaranthus* plants and burn such plants. Sanitise all clothing of all *Amaranthus* material, especially seed.
b. Phase 2: Follow-up after the initial clean sweep with a desiccant herbicide.
c. Phase 3: Scout peripheral areas for Palmer amaranth and remove all *Amaranthus* plants. Burn these plants as explained above.
d. Phase 4: Scout the areas where *Amaranthus* was removed after harvest and during the dry season. Remove any emerging Palmer amaranth during this season and burn as explained above.
e. Phase 5: Apply a pre-emergence herbicide mixture before the next planting season Oct-Dec 2019.
f. Phase 6: Apply an early post-emergence herbicide mixture during planting in Oct-Dec 2019.
g. Phase 7: Apply a post-emergence herbicide mixture the summer 2019-2020 growth season. Remove all surviving *Amaranthus* plants and burn as described above.
h. Phase 8: Apply a desiccant herbicide after the 2020 harvesting has been completed.

DO NOT ALLOW ANY VEGETATIVE PARTS OF ANY *AMARANTHUS* PLANTS TO REMAIN IN THE AFFECTED CROP FIELDS AFTER MANUAL WEEDING AND BURNING AS SUCH PARTS SPROUT AND PROLIFERATE EASILY!! THE OBJECTIBVE IS TO ERADICATE THE SPECIES COMPLETELY!

VERY IMPORTANT DIRECTIVE ABOUT RESISTANCE MANAGEMENT: ROTATE ACTIVE INGREDIENTS TO PREVENT ANY FURTHER RESISTANCE DEVELOPMENT IN THE PALMER AMARANTH AND OTHER WEED SPECIES. EACH ACTIVE INGREDIENT'S RESISTANCE GROUP IS ON THE LABEL OF THE HERBICIDE AND ALSO GIVEN IN THE TABLES.

4. Implement the eradication programme.

Important: Source appropriate herbicides (enough to do all the phases for the infested area on the farm in cultivated fields and fallow areas).

Warning! Do not *blindly* use herbicide active ingredients listed in red in Table 1 registered against *Amaranthus* species in the affected areas *on their own*, especially Glyphosate, Mesotrione and Chlorimuron. It is strongly advised to use registered tank mixtures with these active ingredients and the other active ingredients to which the Palmer amaranth may be resistant. Farmers should do a quick spot spray test with herbicides and registered tank mixtures to assess their efficacy against the Palmer amaranth as some of those that are ineffective against the weed in the USA may be effective in South Africa.

Phase 1 - immediate clean sweep by (a) hand weeding the infested area as much as practical or by (b) applying a desiccant herbicide.

a. Action 1 (a): Pull all the emerged Palmer amaranth out by hand as much as practical, stack in large mounds and burn with an accelerant (petroleum fuel) (mark the treated area with flags where Palmer amaranth was piled and burned to go back and spray any future germinated plants with non-selective herbicide), or
b. Action 1(b): Spray the entire stand of the weed with paraquat dichloride at a dosage of 5 litre per hectare in 500 litre water per hectare (ensure that all workers who mix or apply paraquat takes all safety measures including wearing full protective clothing).
c. Action 2(b) After total desiccation, burn fields with a hot fire (follow approved procedures).
d. Action 3(a&b): After burning, plough fields to a depth of 500 mm.

Phase 2 – follow-up after initial hand weeding or application of the desiccant herbicide.

a. Action 1: Scout for unaffected *Amaranthus* stands and (a) remove all plants by hand weeding, stacking and burning, or (b) spray paraquat dichloride with knapsacks (ensure that all workers who mix or apply paraquat wear full protective clothing)
b. Action 2: After desiccation with the paraquat, burn plants *in situ* or remove, stack and burn (mark the treated area with flags where Palmer amaranth was piled and burned to go back and spray any future germinated plants with non-selective herbicide).
c. Action 3: Revisit sites where plants were stacked and burned for any sprouting or seed germination and kill such plants by repeating Action 1 as stated above.

Phase 3 – scouting and cleaning of peripheral areas.

a. Action 1: Scout peripheral areas on the farm, especially drainage lines, hedge rows, farm roads, road verges, embankments and fallow fields for any pigweed stands.
b. Action 2: Remove such plants by hand weeding, stack and burn, mark the treated area with flags where Palmer amaranth was piled and burned to go back and spray any future germinated plants with non-selective herbicide. The burning must be done in a shallow trench off the crop field to prevent any run-off water after rain collecting seed and dispersing it further. All clothing worn during this exercise must be properly cleaned of all *Amaranthus* material especially seed.

Phase 4 – scouting and cleaning of all areas after harvest and during the dry season.

a. Action 1: Scout all areas where *Amaranthus* was eradicated in crop fields and peripheral areas.
b. Action 2: Remove all regrowth or germinated *Amaranthus* hand weeding, stack and burn, mark the treated area with flags where Palmer amaranth was piled and burned to go back and spray any future germinated plants with non-selective herbicide …

Phase 5 – start clean with the next planting season: do pre-plant application of pre-emergence herbicide mixtures to obtain a maximum killing effect of all *Amaranthus* species.

a. Action 1: Apply pre-emergence herbicide mixtures to all fields that are earmarked for cultivation where the weed was found during the previous production season or where the weed is likely to emerge.
b. Action 2: Apply pre-emergence herbicide mixtures to areas adjacent to fields earmarked for cultivation.

Phase 6 – early post-emergence herbicide application during planting.

a. Action 1: Apply pre-emergence and early post-emergence herbicides during planting.

Phase 7 – application of post-emergence herbicides during the growth season.

a. Action 1: Apply mixture of post-emergence herbicides during growth season.

NB! WHENEVER WEEDS RESEMBLING ANY *AMARANTHUS* SPECIES GERMINATE, THE WEEDS MUST BE SPRAYED AS SOON AS POSSIBLE WITH THE MAXIMUM DOSAGE AS DIRECTED BY THE HERBICIDE LABEL INSTRUCTIONS. PALMER AMARANTH TALLER THAN 6 CM CAN FLOWER AND PRODUCE SEED, HENCE IT NEEDS TO BE ERADICATED BEFORE IT BECOMES PRODUCTIVE!

5. Sanitize all harvesters, tractors, associated implements and other items.

In order to quarantine the seed on the sites where the *Amaranthus* is prevalent the following measures need to be implemented to prevent seed dispersal:

a. Clean all tractors, harvesters, balers and associated implements and sterilize seed that may come off such implements.

b. Move such implements to a hard surface (preferably concrete).

c. Use an industrial grade vacuum cleaner and vacuum the hidden areas of the implements to remove any plant residues.

    i. Once completed, burn the vacuumed material.

d. Hose the implements down and contain the rinse water.

    i. Evaporate the rinse water and burn any residual material.

e. Do not share any implements that were used in *Amaranthus* infested areas in *Amaranthus* free areas unless such equipment is fully sanitised.

f. Do not share any implements that were used in *Amaranthus* infested areas with any other farms even if it is suspected that they may have resistant *Amaranthus* populations unless such equipment is fully sanitised.

g. Normal vehicles must be restricted from entering infested areas especially when the *Amaranthus* is seeding. Vehicles that have entered infested areas must be sanitised before leaving the farm.

h. Farm workers that worked in infested area must sanitise their footwear and clothing before leaving such areas.

6. Contain infested crops on the farm.

In order to prevent *Amaranthus* seed dispersal *via* harvested crops the following phytosanitary measures must be implemented:

a. No cotton may leave the farm.

b. No lucerne or other broad-leaved fodder crops may leave the farm.

c. Harvested grain may only be used as animal feed and not for re-planting.

d. No plant residues may be baled for animal feed and leave the farm.

e. It may be required to sacrifice heavily infested crops and destroy it during *Amaranthus* eradication.

CROPS MAY ONLY LEAVE THE FARM IF A BUYER IS GEARED TO QUARANTINE THE CROPS AND PREVENT DISSEMINATION OF SEED!!

ALTHOUGH SOUTH AFRICA CURRENTLY HAS NO LEGISLATIVE TOOLS TO ENFORCE ERADICATION OF THE PALMER AMARANTH, A PERSON THAT IS RESPONSIBLE FOR INFECTING NEIGHBOURING FARMS WITH THIS VERY DANGEROUS INVASIVE PLANT MAY BE HELD LIAIBLE FOR DAMAGES TO PROPERTY AND ECONOMIC ACTIVITIES BY AFFECTED PARTIES!!

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Technical information on herbicides registered for Amaranthus species control.

Table 1. Herbicides registered under Act No. 36 of 1947 for *Amaranthus* species in crops. Red HRAC group indicates confirmed Palmer amaranth resistance in South Africa, blue indicates possible Palmer amaranth resistance in South Africa (but not scientifically confirmed as yet) and green indicates no Palmer amaranth resistance suspected or recorded at presence

List of herbicide active ingredients registered for *Amaranthus* Red = *A.palmeri* is resistant (confirmed); Blue = possible A. palmeri resistance; Green = *A. palmeri* is susceptible to the active ingredient			
Active ingredient(s)	**HRAC-Group**	**Chemical family**	**Registered for use on the following crops**
Chlorimuron-ethyl	**B**	Sulfonylurea	Soybeans, sugarcane
Diclosulam	**B**	Triazolopyrimidine	Groundnuts, soybeans
Flumetsulam	**B**	Triazolopyrimidine	Dry beans, green beans, groundnuts, maize, soybeans, clovers, cowpeas, lucerne, leguminous pastures
Glufosinate-ammonium	**H**	Phosphinic acid	Tree nuts, stone fruit, pome fruit, citrus, wine and table grapes, mangoes, pawpaws, potatoes
Halosulfuron-methyl	**B**	Sulfonylurea	Citrus, grain sorghum, maize, sugarcane, avocadoes, mangoes, tobacco, wheat
Imazamox	**B**	Imidazolinone	Canola, clover, lucerne, leguminous pastures, medics, seradella (pasture)
Imazamox/Imazapyr	**B**	Imidazolinone	Sunflower
Imazethapyr	**B**	Imidazolinone	Dry beans, groundnuts, soybean
Flumetsulam/Sulcotrione	**B/F2**	Triazolopyrimidine/ Triketone	Maize
Ametryn	**C1**	Triazine	Bananas, Cassava, pineapples, sugarcane
Amicarbazone	**C1**	Triazolinone	Sugarcane
Atrazine	**C1**	Triazine	Grain sorghum, maize, pineapples, sugarcane, canola
Atrazine/Cyanizine	**C1**	Triazine	Maize, sweetcorn, sugarcane
Atrazine/Terbuthylazine	**C1**	Triazine	Grain sorghum, maize
Bromacil	**C1**	Triazine	Citrus, pineapples
Hexazinone	**C1**	Triazinone	Sugarcane
Metamitron	**C1**	Triazinone	Beetroot, sugar beet
Metribuzin	**C1**	Triazinone	Potatoes, sugarcane, tomatoes, barley, lucerne, asparagus, leguminous pastures, maize
Prometryn	**C1**	Triazine	Carrots, cotton, peas
Simazine	**C1**	Triazine	Apples, asparagus, canola (triazine resistant), citrus, grapes, pears, lupines
Simazine/Terbuthylazine	**C1**	Triazine	Apples, canola (triazine resistant), citrus, grapes, pears
Terbuthylazine	**C1**	Triazine	Apples, citrus, grapes, maize, grain sorghum
Terbutryn	**C1**	Triazine	Groundnuts, peas
Atrazine/Sulcotrione	**C1/F2**	Triazine/Triketone	Maize, sugarcane, sweetcorn

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Active ingredient(s)	**HRAC-Group**	**Chemical family**	**Registered for use on the following crops**
Atrazine/Mesotrione/S-Metolachlor	**C1/F2/K3**	Triazine / Triketone/ Chloroacetamide	Maize
Atrazine/Metazachlor/Terbuthyl-azine	**C1/K3**	Triazine / Chloroacetamide	Maize
Atrazine/Metolachlor	**C1/K3**	Triazine / Chloroacetamide	Maize
Atrazine/Metolachlor/Terbuthylazine	**C1/K3**	Triazine / Chloroacetamide	Maize
Atrazine/S-Metolachlor	**C1/K3**	Triazine / Chloroacetamide	Grain sorghum, maize, sugarcane
Atrazine/S-Metolachlor/Terbuthylazine	**C1/K3**	Triazine / Chloroacetamide	Maize
Atrazine/Bendioxide	**C1/Unknown**	Triazine / Unknown	Grain sorghum, maize
Diuron	**C2**	Urea	Avocadoes, bananas, coffee, macadamias, mangoes, pecans, pineapples, sugarcane, citrus
Linuron	**C2**	Urea	Carrots, gladioli, maize, parsley, parsnip, potatoes, sweet potatoes
Fluometuron/Prometryn	**C2(F3)/C1**	Urea / Triazine	Cotton
Diuron/Metribuzin	**C2/C1**	Urea / Triazinone	Sugarcane
Diuron/Terbacil	**C2/C1**	Urea / Uracil	Apples, pears, plums
Diuron/Paraquat	**C2/D**	Urea / Bipyridilium	Sugarcane
Bromoxynil	**C3**	Nitrile	Barley, grain sorghum, lucerne, leguminous pastures, maize, oats, wheat
Ioxynil	**C3**	Nitrile	Garlic, onions
Bendioxide	**C3**	Thiadiazine	Barley, chillies, dry beans, grain sorghum, green beans, green peppers, groundnuts, maize, oats, peas, potatoes, paprika, rye, soybeans, wheat
Bromoxynil/Terbuthylazine	**C3/C1**	Nitrile/Triazine	Forage sorghum, grain sorghum, maize, sugarcane, sweetcorn
Flumioxazin	**E**	N-phenylphthalimide	Apples, citrus, grapes, groundnuts, nectarines, peaches, pears, plums, prunes, soybeans, cotton
Fomesafen	**E**	Diphenylether	Dry beans, green beans, groundnuts, soybean
Oxadiazon	**E**	Oxadiazole	Apples, apricots, citrus, grapes, onions, rice, paprika, peaches, pears, plums, prunes, tobacco
Oxyfluorfen	**E**	Diphenylether	Apples, apricots, broccoli, brussels sprouts, cabbage, cauliflower, garlic, onions, grapes, citrus, cherries, nectarines
Pyraflufen-ethyl	**E**	Phenylpyrazole	Barley, wheat

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Active ingredient(s)	**HRAC-Group**	**Chemical family**	**Registered for use on the following crops**
Saflufenacil/Dimethenamid-*P*	E/K3	Pyrimidindione/ Chloroacetamide	Maize, sugarcane
Flurochloridone	F1	Other	Sunflower
Isoxaflutole	F2	Isoxaxole	Sugarcane
Mesotrione	F2	Triketone	Maize, sugarcane
Sulcotrione	F2	Triketone	Maize
Topramezone	F2	Triketone	Maize
Topramezone/Dicamba	F2/O	Triketone / Benzoic acid	Maize
Mesotrione/S-Metolachlor	F2/K3	Triketone / Chloroacetamide	Maize
Mesotrione/S-Metolachlor/Terbuthylazine	F2/K3/ C1	Triketone / Chloroacetamide/ Triazine	Sugarcane
Clomazone	F3	Isoxazolidinone	Soybeans, tobacco
Glyphosate/Mesotrione/S-Metolachlor	G/F2/K 3	Glycine/Triketone/ Chloroacetamide	RR-maize
Oryzalin	K1	Dinitroaniline	Apples, apricots, grapes, nectarines, peaches, pears, plums
Pendimethalin	K1	Dinitroaniline	Cotton, dry beans, groundnuts, kidney beans, potatoes, soybeans, sugarcane, sunflower, tobacco
Trifluralin	K1	Dinitroaniline	Apples, apricots, barley, cabbage, canola, carrots, cherries, chillies, citrus, cotton, cowpeas, dry beans, groundnuts, kidney beans, soybeans, sunflower, tomatoes, wheat, grapes
Acetochlor	K3	Chloroacetamide	Groundnuts, maize, potatoes, sweetcorn, sugarcane, dry beans, soybeans, cotton, forage sorghum,
Dimethenamid-P	K3	Chloroacetamide	Dry beans, grain sorghum, groundnuts, kidney beans, maize, potatoes, soybeans, sunflower, tobacco
Metazachlor	K3	Chloroacetamide	Broccoli, Cabbage, Canola, dry beans, groundnuts, potatoes, soybeans, sugarcane, tobacco
Metolachlor	K3	Chloroacetamide	Dry beans, groundnuts, maize, soybeans, sugarcane, sunflower, potatoes, kidney beans, green beans, lupines, grain sorghum, tobacco, forage sorghum
S-Metolachlor	K3	Chloroacetamide	Cotton, dry beans, green beans, groundnuts, kidney beans, lupines, maize, grain sorghum, potatoes, forage sorghum, soybeans, sunflower
Acetochlor/Ametryn	K3/C1	Chloroacetamide / Triazine	Sugarcane

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Active ingredient(s)	**HRAC-Group**	**Chemical family**	**Registered for use on the following crops**
Acetochlor/Atrazine/Simazine	**K3/C1**	Chloroacetamide / Triazine	Maize
Acetochlor/Atrazine/Terbuthylazine	**K3/C1**	Chloroacetamide / Triazine	Maize
Alachlor/Atrazine	**K3/C1**	Chloroacetamide / Triazine	Maize
Alachlor/Prometryn	**K3/C1**	Chloroacetamide / Triazine	Potatoes, sunflower
S-Metolachlor/Terbuthylazine	**K3/C1**	Chloroacetamide / Triazine	Apples, avocadoes, citrus, grain sorghum, grapes, maize mangoes
Alachlor/Linuron	**K3/C2**	Chloroacetamide / Urea	Potatoes
Acetochlor/EPTC	**K3/N**	Chloroacetamide / Thiocarbamate	Maize
EPTC	**N**	Thiocarbamate	Dry beans, kidney beans, potatoes, sunflower, maize, green beans, lucerne, leguminous pastures, sugarcane, sweetcorn, sweet potato,
2,4-D	**O**	Phenoxy-carboxylic-acid	Grass pastures, Sugarcane, Wheat, Barley, grain sorghum, maize, rye, potatoes
2,4-D/Dicamba	**O**	Phenoxy-carboxylic-acid / Benzoic acid	Maize, sugarcane, wheat, grass pastures
2,4-DB	**O**	Phenoxy-carboxylic-acid	Clover, lucerne, leguminous pastures, medics, wheat
Dicamba	**O**	Benzoic acid	Grain sorghum, maize, wheat
MCPA	**O**	Benzoic acid	Apples, Barley, Grapes, Grass pastures, maize, peaches, pears, potatoes, rye, grain sorghum, sugarcane, wheat, oats
Dicamba/Topramezone	**O/F2**	Benzoic acid / Triketone	Maize
Bendioxide	**C3**	Thiadiazine	Barley, chillies, dry beans, grain sorghum, green beans, green peppers, groundnuts, maize, oats, peas, potatoes, paprika, rye, soybeans, wheat
MSMA	**Z**	Organo-arsenical	Cotton, sugarcane

RECOMMENDED HERBICIDE SPRAY PROGRAMMES TO ERADICATE EXISTING PALMER AMARANTH STANDS AND TO PREVENT GERMINATION AND GROWTH

The control of Palmer amaranth with herbicides must be aggressive and pro-active. Pre-plant burndown, pre-emergence and early post-emergence herbicides must be used in a diligent spray program to control and eradicate this weed in crops. Relying only on post-emergence herbicides is not a viable option due to the rapid growth rate of Palmer amaranth. It is imperative to start clean and stay clean.

Before planting crops use a pre-plant burndown, non-selective herbicide(s) with **paraquat.** It is imperative to burn the desiccated weeds to destroy any vegetative parts and seeds of Palmer amaranth.

The following tables list active ingredients registered for the use on *Amaranthus* spp., sorted by ***time of application*** on various crops. Please adhere to all label instructions when applying herbicides. Good, clean and correctly calibrated equipment must be used to ensure effective control. Adhere to mixing instructions on all relevant labels when tank-mixtures are being used. Please contact HRAC-SA or the respective supplier of products for further information.

Table 2. Pre-plant herbicide active ingredients registered on *Amaranthus* spp.

Before planting crops, herbicide(s) containing the following active ingredients can be used.

Active ingredient(s)	HRAC-Group	Registered for use on the following crops	Time of application
EPTC	N	Dry beans, kidney beans, potatoes, sunflower, maize, green beans, lucerne, leguminous pastures, sugarcane, sweetcorn, sweet potato,	Pre-plant
Trifluralin	K1	Apples, apricots, barley, cabbage, canola, carrots, cherries, chillies, citrus, cotton, cowpeas, dry beans, groundnuts, kidney beans, soybeans, sunflower, tomatoes, wheat, grapes	Pre-plant

Table 3. Pre-emergence herbicide active ingredients registered on *Amaranthus* spp.

NB: Herbicides containing the following active ingredient(s) can be applied ***after planting*** but ***before*** emergence of both the crop and weed.

Pre-mergence herbicides *must be applied* to ensure early control and seedbank depletion of any germinating Palmer amaranth.

Active ingredient(s)	HRAC-Group	Registered for use on the following crops	Time of application
Acetochlor	K3	Groundnuts, maize, potatoes, sweetcorn, sugarcane, dry beans, soybeans, cotton, forage sorghum	Pre-emergence
Acetochlor/Atrazine/Simazine	K3/C1	Maize	Pre-emergence
Acetochlor/Atrazine/Terbuthylazine	K3/C1	Maize	Pre-emergence
Acetochlor/EPTC	K3/N	Maize	Pre-emergence
Alachlor/Atrazine	K3/C1	Maize	Pre-emergence

Active ingredient(s)	HRAC-Group	Registered for use on the following crops	Time of application
Alachlor/Linuron	K3/C2	Potatoes	Pre-emergence
Alachlor/Prometryn	K3/C1	Potatoes, sunflower	Pre-emergence
Atrazine	C1	Grain sorghum, maize, pineapples, sugarcane, canola	Pre-emergence
Atrazine/Cyanizine	C1	Maize, sweetcorn, sugarcane	Pre-emergence
Atrazine/Mesotrione/S-Metolachlor	C1/F2/ K3	Maize	Pre-emergence
Atrazine/Metolachlor	C1/K3	Maize	Pre-emergence
Atrazine/Metolachlor/Terbu-thylazine	C1/K3	Maize	Pre-emergence
Atrazine/S-Metolachlor	C1/K3	Grain sorghum, maize, sugarcane	Pre-emergence
Atrazine/S-Metolachlor/Terbuthylazine	C1/K3	Maize	Pre-emergence
Atrazine/Sulcotrione	C1/F2	Maize, sugarcane, sweetcorn	Pre-emergence
Clomazone	F3	Soybeans, tobacco	Pre-emergence
Diclosulam	B	Groundnuts, soybeans	Pre-emergence
Dimethenamid-*P*	K3	Dry beans, grain sorghum, groundnuts, kidney beans, maize, potatoes, soybeans, sunflower, tobacco	Pre-emergence
Flumetsulam	B	Dry beans, green beans, groundnuts, maize, soybeans, clovers, cowpeas, lucerne, leguminous pastures	Pre-emergence
Flumetsulam/Sulcotrione	B/F2	Maize	Pre-emergence
Flumioxazin	E	Apples, citrus, grapes, groundnuts, nectarines, peaches, pears, plums, prunes, soybeans, cotton	Pre-emergence
Flurochloridone	F1	Sunflower	Pre-emergence
Imazamox	B	Canola, clover, lucerne, leguminous pastures, medics, seradella (pasture)	Pre-emergence
Imazamox/Imazapyr	B	Sunflower	Pre-emergence
Imazethapyr	B	Dry beans, groundnuts, soybean	Pre-emergence

Active ingredient(s)	HRAC-Group	Registered for use on the following crops	Time of application
Mesotrione	F2	Maize, sugarcane	Pre-emergence
Mesotrione/S-Metolachlor	F2/K3	Maize	Pre-emergence
Metazachlor	K3	Broccoli, Cabbage, Canola, dry beans, groundnuts, potatoes, soybeans, sugarcane, tobacco	Pre-emergence
Metolachlor	K3	Dry beans, groundnuts, maize, soybeans, sugarcane, sunflower, potatoes, kidney beans, green beans, lupines, grain sorghum, tobacco, forage sorghum	Pre-emergence
Metribuzin	C1	Potatoes, sugarcane, tomatoes, barley, lucerne, asparagus, leguminous pastures	Pre-emergence
Pendimethalin	K1	Cotton, dry beans, groundnuts, kidney beans, potatoes, soybeans, sugarcane, sunflower, tobacco	Pre-emergence
Prometryn	C1	Carrots, cotton, peas	Pre-emergence
S-Metolachlor	K3	Cotton, dry beans, green beans, groundnuts, kidney beans, lupines, maize, grain sorghum, potatoes, forage sorghum, soybeans, sunflower	Pre-emergence
S-Metolachlor/Terbuthy-lazine	K3/C1	Apples, avocadoes, citrus, grain sorghum, grapes, maize mangoes	Pre-emergence
Terbutryn	C1	Groundnuts, peas	Pre-emergence
Topramezone	F2	Maize	Pre-emergence
Topramezone/Dicamba	F2/O	Maize	Pre-emergence
Atrazine/Metazachlor/Ter-buthylazine	C1/K3	Maize	Pre-emergence and early Post-emergence
Fluometuron/Prometryn	C2(F3) /C1	Cotton	Pre-emergence and early Post-emergence
Sulcotrione	F2	Maize	Pre-emergence and early Post-emergence
Dicamba	O	Grain sorghum, maize, wheat	Pre-emergence and Post-emergence (depending on crop stage)
Atrazine/Terbuthylazine	C1	Grain sorghum, maize	Pre-emergence or early Post-emergence
Terbuthylazine	C1	Apples, citrus, grapes, maize, grain sorghum	Pre-emergence or early Post-emergence

Table 4. Early post-emergence herbicide active ingredients registered on *Amaranthus* spp. Herbicides containing the following active ingredient(s) can be applied after emergence of both the crop and the weed.

All post-emergence applications must be done as early as possible. Best control will be achieved when Palmer amaranth is between the **2nd and 4th leaf stage**. Any attempt to apply post-emergence herbicides **when Palmer amaranth is taller than 10 cm will result in poor to no control. Prevent flowering and shedding of seed at all costs.**

Active ingredient(s)	HRAC-Group	Registered for use on the following crops	Time of application
Atrazine/Bendioxide	C1/C3	Grain sorghum, maize	Early post-emergence
Bendioxide	C3	Barley, chillies, dry beans, grain sorghum, green beans, green peppers, groundnuts, maize, oats, peas, potatoes, paprika, rye, soybeans, wheat	Early post-emergence
Bromoxynil	C3	Barley, grain sorghum, lucerne, leguminous pastures, maize, oats, wheat	Early post-emergence
Bromoxynil/Terbuthylazine	C3/C1	Forage sorghum, grain sorghum, maize, sugarcane, sweetcorn	Early post-emergence
Chlorimuron-ethyl	B	Soybeans, sugarcane	Early Post-emergence
Dicamba/Topramezone	O/F2	Maize	Early Post-emergence
Fomesafen	E	Dry beans, green beans, groundnuts, soybean	Early Post-emergence
Glufosinate-ammonium	H	Tree nuts, stone fruit, pome fruit, wine and table grapes, citrus, mangoes, pawpaws, potatoes	Early Post-emergence
Glyphosate/Mesotrione/S-Metolachlor	G/F2/K3	RR-maize	Early Post-emergence
MSMA	Z	Cotton, sugarcane	Early Post-emergence
Pyraflufen-ethyl	E	Barley, wheat	Early Post-emergence
2,4-D	O	Grass pastures, Sugarcane, Wheat, Barley, grain sorghum, maize, rye, potatoes	Post-emergence (depending on crop stage)
2,4-D/Dicamba	O	Maize, sugarcane, wheat, grass pastures	Post-emergence (depending on crop stage)

Active ingredient(s)	HRAC-Group	Registered for use on the following crops	Time of application
2,4-DB	O	Clover, lucerne, leguminous pastures, medics, wheat	Post-emergence (depending on crop stage)
MCPA	O	Apples, Barley, Grapes, Grass pastures, maize, peaches, pears, potatoes, rye, grain sorghum, sugarcane, wheat, oats	Post-emergence (depending on crop stage)

LABELS OF HERBICIDES CONTAINING THE ACTIVE INGREDIENTS LISTED IN THIS DOCUMENT ARE AVAILABLE ON AGRIINTEL WWW.AGRI-INTEL.COM. USE THE HERBICIDES ONLY AS DIRECTED BY THEIR LABEL INSTRUCTIONS. FOR ANY CLARITY, CONTACT THE REGISTRATION HOLDERS OF THE RESPECTIVE HERBICIDES.

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HERBICIDE RESISTANCE ACTION COMMITTEE South Africa