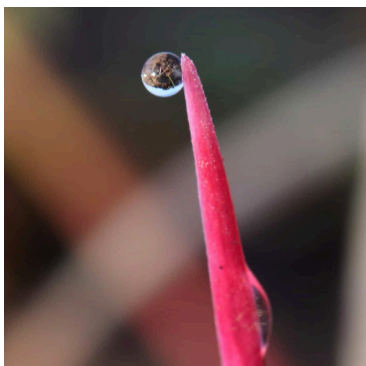




ISO FLEXTM active

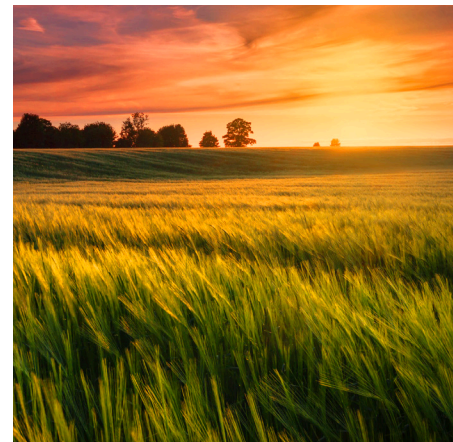
Global Technical
Bulletin



IsoplexTM active is not yet registered for sale or use in all countries. No offer for sale, sale, or use of this product is permitted prior to issuance of the required registrations by the relevant regulatory entity.

Introduction

FMC's bixlozone herbicide, trademarked Isoflex™ active (containing the active ingredient (ai) bixlozone), is a unique selective herbicide for use in crops like cereals, canola, oilseed rape, corn and sugarcane. Products containing Isoflex™ active provide residual and early post-emergence control of small-seeded broadleaves and are especially active on annual grass weeds. Isoflex™ active provides good crop tolerance and serves as an excellent mixing partner in several cropping systems. Isoflex™ active is only the second herbicide representing the isoxazolidinone family, preventing carotenoid biosynthesis in susceptible plants via inhibiting DXP synthase.



Features & Benefits

KEY FEATURES

Isoflex™ active belongs to the isoxazolidinone family, the same chemical family as the FMC active clomazone (various trade names), with a history of success and recognition for its adaptability and preventive weed control.

When used in cereal crops, products containing Isoflex™ active are considered a new novel herbicide mode of action.

Products containing Isoflex™ active can be used to control weeds prior to planting through early crop growth stage in many of the registered crops (please refer to the product label for proper usage), providing a flexible application window for targeting problematic weeds.

CROP PRODUCTION BENEFITS

To date, products containing Isoflex™ active have exhibited pre-plant, pre-emergence and early post-emergence selectivity in major crops, including cereals, canola, oilseed rape, corn and sugarcane; research into other crops and segments is ongoing.

Products containing Isoflex™ active provide excellent control of key annual grass weeds, including ryegrass (*Lolium* spp.), barnyardgrass (*Echinochloa* spp.), crabgrass (*Digitaria* spp.), foxtail (*Setaria* spp.), canarygrass (*Phalaris* spp.), goosegrass (*Eleusine indica*), bluegrass (*Poa* spp.) and suppression of blackgrass (*Alopecurus myosuroides*).

It also provides exceptional control of key broadleaf weeds, such as common chickweed (*Stellaria media*), speedwells (*Veronica* spp.), shepherd's purse (*Capsella bursa-pastoris*) and wild chamomile (*Matricaria chamomilla*), as a solo product and complementary mixture partner with other broadleaf herbicides.

As a Group 13 (HRAC) herbicide, it provides a new tool for resistance management in select crops to help growers across a wide range of agronomic practices.

Herbicide resistance to this mode of action is rare, with only three global populations characterized according to the International Herbicide-Resistant Weed Database (Heap 2022).

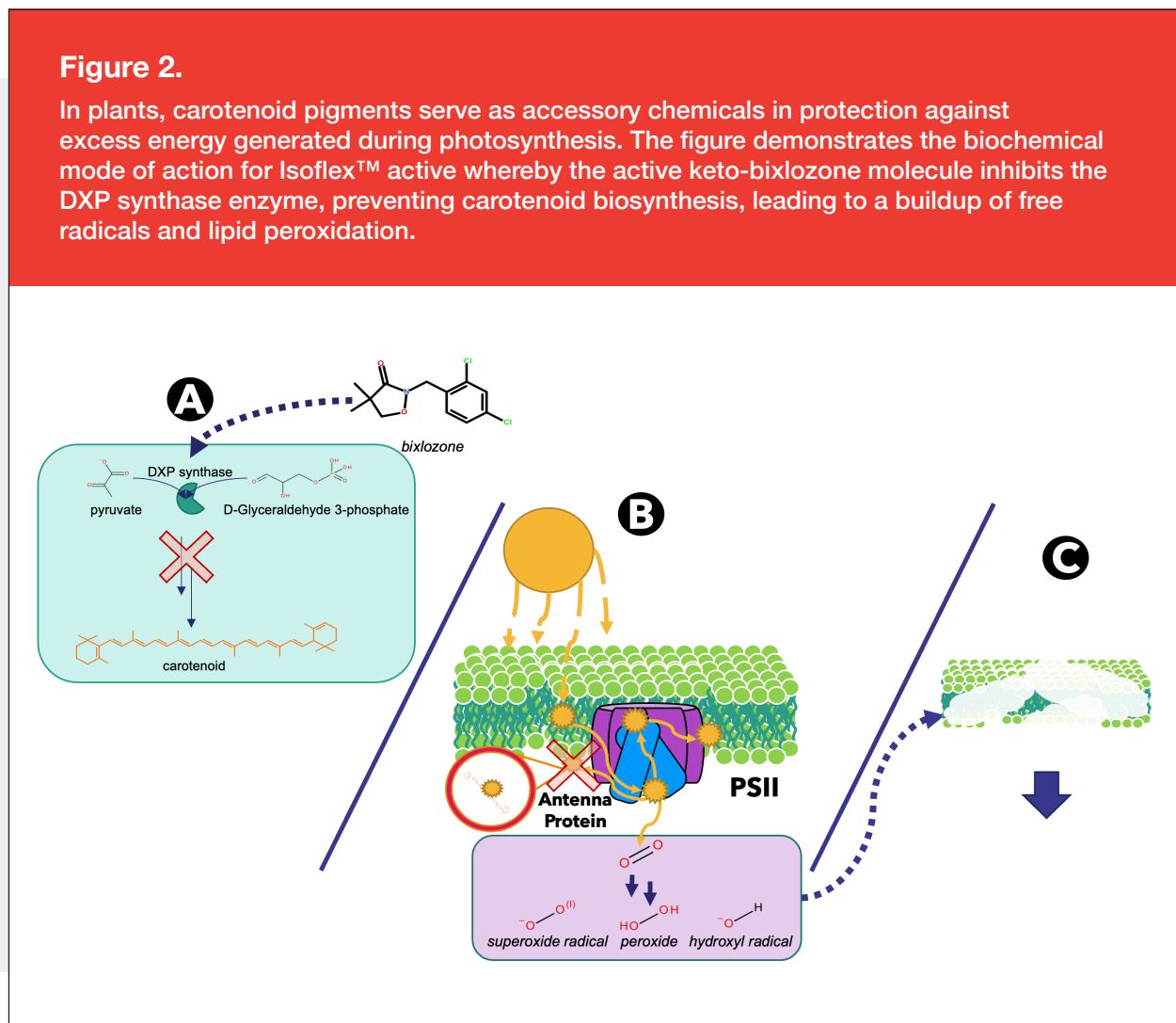


Mode of Action (continued)

DXP synthase is the known target site for Isoflex™ active; however, the plant is ultimately injured and/or killed from the disruption in carotenoid biosynthesis and photodamage due to the extensive role of the DOXP pathway and the use of the terpenoid backbone in other processes (Figure 2).

Figure 2.

In plants, carotenoid pigments serve as accessory chemicals in protection against excess energy generated during photosynthesis. The figure demonstrates the biochemical mode of action for Isoflex™ active whereby the active keto-bixlozone molecule inhibits the DXP synthase enzyme, preventing carotenoid biosynthesis, leading to a buildup of free radicals and lipid peroxidation.



The above describes only the primary mode of action resulting in the visible symptoms (bleaching); additional pleiotropic effects due to a lack of terpenoids affecting secondary metabolite formation and hormones are also impacted.

Mode of Action (continued)

Selectivity

Crop selectivity in labeled crops is primarily through plant metabolism and herbicide placement when using products containing Isoflex™ active as a pre-emergence application.

To avoid significant injury, it is best to avoid direct contact of the herbicide with the seed; always follow the seeding depth recommendation on the label for the specific crop. If seeding is too shallow, typical symptomology will occur (Figure 3).

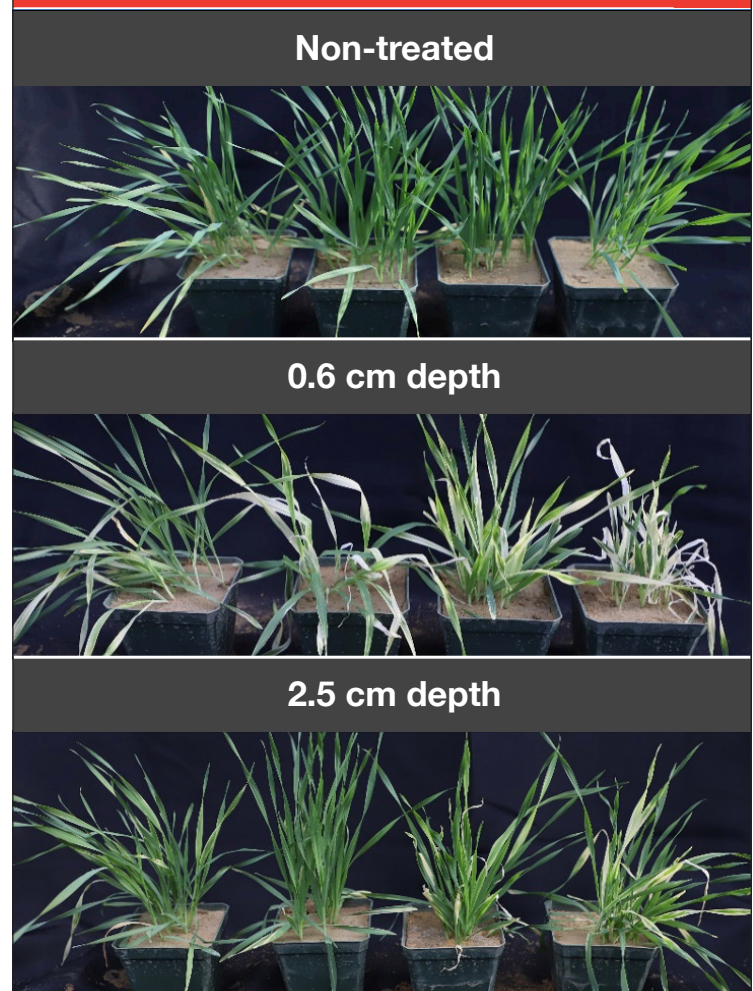
If injury does occur when following label recommendations, resulting in crop bleaching, the symptoms should be considered transient with no long-term impact on yield.

Environmental factors that reduce the physiological activity of the plant (including low temperatures and high soil moisture) may result in higher than anticipated visible injury to labeled crops.



Figure 3.

Comparison of the response for barley (HORSS) treated with Isoflex™ active applied at 500 g/ha across four varieties at common seeding depths.



Mode of Action (continued)

Symptomology

Visible symptoms depend on the innate plant tolerance to the chemistry and a function of the dose applied.

- On grasses, bleaching typically occurs as lines or streaks of the leaf veins or whitening of the entire leaf (Figure 4).
- Chlorosis of the areas between the veins and leaf margins is also possible at reduced application rates or in less susceptible species.
- Some species may turn completely white or have a color transitioning from chlorotic (yellowing) to white.
- In some instances, especially with *Lolium* spp., a characteristic symptom is a pink discoloration due to the presence of anthocyanin in the absence of chlorophyll (Figure 4).

Uptake and Translocation

Products containing Isoflex™ active can be applied directly to the soil surface on germinating and newly emerged weeds (\leq BBCH 11).

When products containing Isoflex™ active are soil-applied, Isoflex™ active is absorbed into the germinating tissue of the emerging hypocotyl/coleoptile or taken up through the roots. Root uptake is the primary mechanism.

When products containing Isoflex™ active are foliar-applied, Isoflex™ active can be absorbed from application on the leaf surface and moved passively into the leaves via diffusion at a relatively slow pace and concentration. Following foliar uptake, Isoflex™ active does not move out of the treated leaves nor redistribute via the phloem.

Figure 4.

Lolium in a wheat field. *Lolium* shifting color to magenta is a visual symptom of Isoflex™ active's activity.



Biological Profile

CROP TOLERANCE

GENERAL INFORMATION

- Products containing Isoflex™ active have good crop tolerance on wheat, barley, canola/oilseed rape, corn and sugarcane in a variety of global management systems.
- Herbicide safeners can be used in some crops to help minimize the visible symptoms from applications of products containing Isoflex™ active.
- Excessive rainfall immediately following application (>5 cm in less than 24 hours) can result in poor performance or crop injury due to the herbicide moving into the seedbed and being taken up by the roots.
- Low organic matter and coarse/sandy soils require lower use rates to prevent crop injury; these porous soils allow Isoflex™ active to move more easily into the seedbed with free water.



CEREALS



- Cereals are the main target crop species for products containing Isoflex™ active.
- Application timing for cereals can occur under any of the following conditions: 60 days prior to planting, post-sowing pre-emergence or up to 3-4 leaves (BBCH 13) for wheat.
- Isoflex™ active is recommended at application rates from 200 to 750 g/ha based on the management conditions and regulatory guidance.
- Spring and winter wheat are generally tolerant to products containing Isoflex™ active. However, it is possible to see light bleaching or chlorosis on early emerging wheat, which is usually gone by about three weeks after treatment.
- Barley is tolerant to products containing Isoflex™ active when applied pre-emergent only; however, under adverse conditions, barley is more susceptible to bleaching and potential stunting of a transient nature if prolonged exposure to the herbicide occurs. Spring barley varieties are also more sensitive compared to winter varieties.
- For pre-emergence application, attention should be given to the seedbed and crop seeding depth, which should be a minimum of 2.5 cm from the surface, to ensure the highest level of crop safety (Figure 3).

Biological Profile (continued)

CANOLA AND OILSEED RAPE



- Products containing Isoflex™ active can be used as a weed control product in canola and oilseed rape. Application should be made as a pre-emergence timing.

CORN



- Corn is tolerant as a pre-emergence application with rates up to 750 g/ha, depending on environmental conditions and soil type.

SUGARCANE

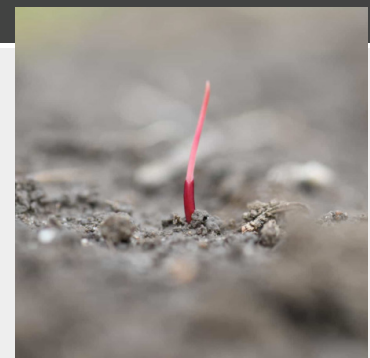


- Sugarcane crop tolerance has been confirmed for both plant and ratoon cane.
- Plant cane tolerance is excellent, with application rates as high as 1600 g/ha, and can be made prior to crop emergence.

WEED CONTROL

GENERAL INFORMATION

- Products containing Isoflex™ active can be applied as a pre-plant, pre-emergence or early post-emergence product to various annual grasses and small-seeded broadleaf weeds.
- Application rates at 500 g/ha can provide control of targeted species for up to ten weeks following application under optimal weather conditions.
- Irrigation or rainfall of approximately 25 to 50 mm following application is recommended to avoid a loss of control of early or fast emerging weed species and maintain long residual activity.
- The application rate of products containing Isoflex™ active is based on the soil texture and properties (i.e., organic matter). Lower rates will be needed in coarse texture whereas higher rates will be necessary in fine-textured soils to achieve similar levels of weed control.



Isoflex™ active will be sold in several markets as a stand-alone product. However, its flexibility in both premixtures and tank mixtures (to expand the weed spectrum and mitigate the risk of resistance development) is a key benefit of Isoflex™ active.

Biological Profile (continued)

| ----- Susceptible Weed Species ----- | | |
|--------------------------------------|--|----------------------|
| Crop(s)* | Scientific Name | Common Name |
| ASIA PACIFIC | | |
| Cereals (wheat/barley) | <i>Arctotheca calendula</i> ** | Capeweed |
| Canola | <i>Avena fatua</i> ** | Wild oat |
| Faba beans | <i>Bifora testiculata</i> | Bifora |
| Field peas | <i>Bromus spp.</i> ** | Brome grass |
| | <i>Capsella bursa-pastoris</i> | Shepherds purse |
| | <i>Descurania Sophia</i> | Flixweed |
| | <i>Galium aparine</i> ** | Catchweed bedstraw |
| | <i>Galium tricornutum</i> ** | Bedstraw |
| | <i>Hordeum murinum</i> ** | Barley grass |
| | <i>Lactuca spp.</i> ** | Prickly lettuce |
| | <i>Lolium rigidum</i> | Annual ryegrass |
| | <i>Phalaris paradox</i> ** | Hood canarygrass |
| | <i>Phalaris spp.</i> | Canarygrass |
| | <i>Polygonum aviculare</i> | Hog weed/wireweed |
| | <i>Raphanus raphanistrum</i> ** | Wild radish |
| | <i>Sonchus oleraceus</i> | Sow thistle |
| | <i>Stellaria media</i> | Common chickweed |
| | <i>Veronica spp.</i> | Speedwells |
| | <i>Vulpia bromoides</i> | Rat's tail fescue |
| EMEA | | |
| Cereals (wheat/barley) | <i>Alopecurus myosuroides</i> ** | Blackgrass |
| Canola | <i>Amaranthus spp.</i> ** | Amaranths |
| Corn | <i>Capsella bursa-pastoris</i> | Shepherds purse |
| Potato | <i>Chenopodium album</i> ** | Common lambsquarters |
| | <i>Echinochloa crus-galli</i> | Barnyardgrass |
| | <i>Galium aparine</i> ** | Catchweed bedstraw |
| | <i>Lamium purpureum</i> | Red deadnettle |
| | <i>Lolium perenne ssp. Multiflorum</i> | Italian ryegrass |
| | <i>Lolium rigidum</i> | Annual ryegrass |
| | <i>Mercurialis annua</i> | Annual mercury |
| | <i>Papaver rhoeas</i> ** | Poppy |
| | <i>Poa spp.</i> | Meadowgrass |
| | <i>Sisymbrium officinale</i> | Hedge mustard |
| | <i>Solanum nigrum</i> ** | Black nightshade |

Biological Profile (continued)

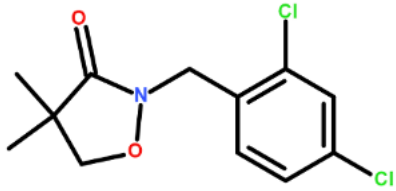
| ----- Susceptible Weed Species ----- | | |
|--------------------------------------|--|--------------------|
| Crop(s)* | Scientific Name | Common Name |
| LATIN AMERICA | | |
| Cereals (wheat/barley) | <i>Brachiaria plantaginea</i> | Signalgrass |
| Cotton | <i>Commelina benghalensis</i> | Bengal dayflower |
| Soybean | <i>Cyperus iria</i> | Rice flat sedge |
| Sugarcane | <i>Digitaria horizontalis</i> | Jamaican crabgrass |
| Tobacco | <i>Digitaria insularis</i> | Sourgrass |
| Rice | <i>Echinochloa crus-galli</i> | Barnyardgrass |
| | <i>Eleusine indica</i> | Indian goosegrass |
| | <i>Lolium perenne ssp. multiflorum</i> | Italian ryegrass |
| | <i>Polygonum spp.</i> | Polygonums |
| | <i>Raphanus raphanistrum**</i> | Wild radish |
| NORTH AMERICA | | |
| Cereals (wheat/barley) | <i>Lamium amplexicaule L.</i> | Henbit |
| | <i>Lolium perenne ssp. multiflorum</i> | Italian ryegrass |
| | <i>Stellaria media</i> | Common chickweed |

*Application rates for each crop are dependent on the labeled use rate for Isoflex™ active products within the registered countries, rates vary based on the agronomic factors and regulatory guidance within and across regions.

** Weeds suppressed, commercially acceptable level of control not expected under all conditions, however, a delay in emergence and/or decrease in the weed population can be expected under recommended use patterns.

Technical Information

Physical and Chemical Properties

| Physical Properties - Technical Active Ingredient | |
|---|---|
| Global Brand Name | Isoflex™ active |
| Code/Experimental Name | F9600 |
| ISO Name | Bixlozone |
| CAS Number | 81777-95-9 |
| Chemical Formula | C ₁₂ H ₁₃ Cl ₂ N ₂ O ₂ |
| IUPAC Name | 2-[(2,4-dichlorophenyl)methyl]-4,4-dimethyl-1,2-oxazolidin-3-one |
| Chemical Class | Isoxazolidinone |
| Structure |  |
| Molecular Weight (g/mol) | 274.14 |
| Appearance | White crystalline solid (PAI) Pale yellow/brown crystalline solid (TGAI) |
| Water Solubility (mg/L) | 42.0 mg/L (purified water) (PAI) |
| Vapor Pressure (Pa) | 2.3×10^{-3} (PAI, 25°C) |
| Henry's Law Constant (20°C, Pa m ³ /mol) | 7.2×10^{-3} |
| Boiling Point (°C) | ND; starts to decompose at 188°C (PAI) |
| Melting Point (°C) | 81.5-83.5 (PAI) |
| Flammability | Not highly flammable (TGAI) |
| Explosive Properties | Not explosive (TGAI) |
| Auto Ignition Temperature | 382°C (TGAI) |
| Oxidizing Properties | Not oxidizing (TGAI) |
| Specific Gravity (Relative Density @20°C) | 1.37 (PAI) |
| Surface Tension (20°C) | 66.5 mN/m (PAI) |
| Decomposition Temperature (°C) | Onset of decomposition 188°C |
| Stability pH | Hydrolytically stable in water |
| KowLogP (20°C) | 3.3 (PAI) |



Technical Information (continued)

Environmental Fate

| | |
|--|-------------|
| Soil Degradation, DT ₅₀ (days) @20°C, pF2.0 | 133.5 (lab) |
| Mobility, Koc (mL/g) | 381.5 |

Toxicological & Eco-Toxicological Properties

| | |
|---|----------------|
| Acute - Oral LD ₅₀ (mg/kg) | >2000 |
| Acute - Dermal LD ₅₀ (mg/kg) | >2000 |
| Inhalation LC ₅₀ (mg/L) | >2.11 |
| Eye Irritation | Not irritating |
| Skin Irritation | Not irritating |
| Birds - Acute Oral LD ₅₀ (mg/kg) | Unclassified |
| WHO Classification | >2000 |
| <i>Daphnia</i> - Acute 48 hour EC ₅₀ (mg/L) | 0.14 |
| Aquatic Invertebrates - Acute 48 hour EC ₅₀ (mg/L) | 13 |
| Honeybees - Contact & Oral Acute 48 hour LD ₅₀ (µg as/bee) | >100 |

This technical bulletin is intended for use only as a guide in providing general information about Isoflex™ active. It must be emphasized that products containing Isoflex™ active must be used in accordance with local regulations and registrations. We strongly recommend that users read, understand, and follow all label directions, warnings and precautions prior to using products containing Isoflex™ active.

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