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A NEW BROAD-SPECTRUM HERBICIDE FOR CITRUS

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Abstract. **DPX-R6447 represents a new family of chemistry to be used in Florida citrus. It is a highly effective citrus herbicide characterized by low use rates. Preliminary toxicology studies indicate the herbicide has low acute oral and dermal toxicity. Citrus has demonstrated excellent tolerance to DPX-R6447 when used for preemergence weed control. Studies to date indicate no yield reductions or maturity delays have resulted from the use of this herbicide. Preemergence applications of DPX-R6447 have resulted in control of most problem weeds in Florida citrus. Key weeds controlled include narrowleaf panicum, vaseygrass, goosegrass, Spanish needles, goatweed, pigweed and balsamapple vine.**

Introduction

DPX-R6447 is a low use rate, preemergence herbicide that provides extended weed control in citrus. Representing a new family of chemistry for citrus growers, DPX-R6447 has the ability to inhibit the enzyme *protoporphyrinogen oxidase*, which is involved in the biosynthesis of chlorophyll. This type of chemistry is known as porphyrin biosynthesis inhibitors.

Characteristics

DPX-R6447 is a highly effective herbicide characterized by low use rates. The anticipated use rate is 16.0 ounces active ingredient per acre. This rate is over 60% less than the common use rates of the currently registered residual herbicides in citrus.

The approved common name for DPX-R6447 is azafenidin. Based on preliminary rat studies, azafenidin has low acute oral and dermal toxicity in rats. Skin exposure studies resulted in no irritation to rabbits, and azafenidin was not mutagenic in the Ames test.

Breakdown of azafenidin within the environment occurs primarily by way of microbial degradation. Hydrolysis appears to play only a minor role in the degradation of the herbicide.

The compound has a low water solubility of 18 ppm, and the octonol-water partition coefficient for azafenidin is Log p = 2.7. The vapor pressure at 20°C is $>2.7 \times 10^{-11}$ Torr. With these attributes, azafenidin has low mobility and leaching potential. Results from predictive groundwater modeling studies indicate low risk to leach in groundwater in the Florida environment. A field groundwater study is underway in Florida to validate the results from the predictive models.

Azafenidin will be formulated as an 80% active dispersible granule. An EUP label is anticipated in the fourth quarter of 1997 as well as a non-bearing citrus label. A full Section 3 bearing citrus label is anticipated in the fourth quarter of 1999. Azafenidin will be registered on all citrus in the United States as well as on sugarcane and other specialty crops.

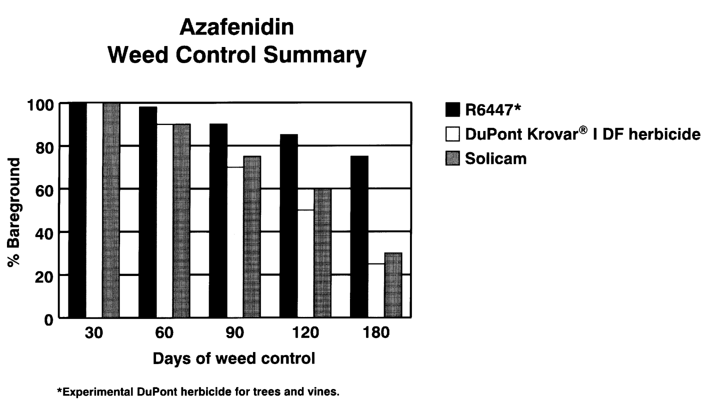

Figure 1. Azafenidin Weed Control Summary

Field Results

Data from Florida tests on various citrus varieties and rootstocks show azafenidin is completely safe to trees, even at rates eight times the anticipated field use rate. Citrus trees have shown no sign of injury from the herbicide treatment, even at rates as high as 128.0 ounces active ingredient per acre. At a use rate of 16.0 ounces active ingredient per acre, azafenidin provides four to six months of commercially acceptable weed control, depending on weather conditions and weed pressure.

Fig. 1 summarizes data from 23 preemergence tests conducted in Florida. Azafenidin, at 16.0 ounces active ingredient per acre, is compared to standard use rates of DuPont Krovar® I herbicide and Solicam[1]. The length of bareground weed control provided by azafenidin is significantly greater than the current standards.

Weeds Controlled

Azafenidin provides control of key weed species in Florida citrus, including guineagrass, narrowleaf panicum, Spanish needles, goatweed and balsamapple vine.

Tables 1, 2 and 3 identify the weeds controlled in citrus when azafenidin is applied preemergence at 16.0 ounces active ingredient per acre. Table 1 lists the grass species, Table 2 lists the broadleaf

Table 1. Grasses (Preemergence)

Bahiagrass	*Paspalum notatum*
Bermudagrass*	*Cynodon dactylon*
Broadleaf signalgrass	*Brachiaria platyphylla*
Carpetgrass	*Axonopus affinis*
Crowfootgrass	*Dactyloctenium aegyptium*
Foxtail, yellow	*Setaria glauca*
Goosegrass	*Eleusine indica*
Guineagrass	*Panicum maximum*
Napiergrass	*Pennisetum purpureum*
Natalgrass	*Rhynchelytrum repens*
Narrowleaf panicum	*Panicum maximum*
Pangolagrass	*Digitaria decumbens*
Paragrass	*Brachiaria mutica*
Sandbur	*Cenchrus echinatus*
Smutgrass	*Sporogolus poiretii*
Texas panicum	*Panicum texanum*
Torpedograss	*Panicum repens*
Vaseygrass	*Paspalum urvillei*

*Suppression or partial control

Table 2. Broadleaves (Preemergence)

Camphorweed	*Heterotheca subaxillaris*
Dayflower	*Commelina benghalensis*
Florida pusley	*Richardia scabra*
Goatweed	*Scoparia dulcis*
Jerusalem oak	*Chenopodium ambrosioides*
Lambsquarters	*Chenopodium album*
Lantana (seedling)	*Lantana camara*
Nightshade, black	*Solanum nigrum*
Nutsedges*	*Cyperus spp.*
Phasey bean	*Macroptilium lathyroides*
Pigweed	*Amaranthus spp.*
Purslane	*Portulaca oleraccea*
Ragweed, common	*Ambrosia artemisiifolia*
Spanish needles	*Bidens pilosa*
Spurge	*Chamaesyce hyssopifolia*
Teaweed	*Sida acuta*
Virginia pepperweed	*Lepidium virginicum*
Vetch, hairy	*Vicia villosa*

*Suppression or partial control

species and Table 3 lists the vine species that are controlled by azafenidin based on field studies to date.

Summary

DuPont is actively developing azafenidin for the Florida citrus market. It should be available to Florida citrus growers for use on

Table 3. Vines (Preemergence)

Balsamapple vine	*Momordica charantia*
Citron	*Citrullus lanatus*
Maypop	*Passiflora incarnata*
Milkweed vine (seedling)	*Morrenia odorata*
Virginia creeper (seedling)	*Parthenocissus quinquefolia*
Peppervine (seedling)	*Ampelopsis arborea*

non-bearing groves by fourth quarter 1997 and for use on bearing groves by fourth quarter 1999.

DuPont has successfully developed and registered several sulfonylurea herbicides, but azafenidin represents a new family of chemistry that functions as a porphyrin biosynthesis inhibitor. It is characterized by low use rates, low toxicity and safety to the environment. Degradation in the environment occurs primarily via microbial pathways.

Citrus has demonstrated excellent tolerance to azafenidin. Studies to date have resulted in excellent preemergence control of most key citrus weeds, including narrowleaf panicum, Spanish needles, goatweed, pigweed, and balsamapple vine.

Development of azafenidin is a part of DuPont's ongoing, long-term commitment to the citrus industry, and we are moving forward as rapidly as possible to bring this new herbicide to the Florida citrus market. We believe azafenidin will provide citrus growers with an important new tool for controlling a broad range of weeds and do so in an environmentally friendly manner.

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METHODS FOR EVALUATION OF SPRAY CHEMICAL PHYTOTOXICITY TO CITRUS

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Abstract. **For Florida citrus, pesticides, nutritionals and growth regulators are often sprayed together in tank mixes in order to reduce sprayer use when timings for efficacy are relatively coincident. Many individual spray components are marginally phytotoxic and can result in spray burns when used together or if applied with adjuvants that increase absorption. The toxicity level of many standard spray materials is unknown and new products are not routinely tested for phytotoxicity in citrus, particularly as tank mixes with other pesticides or nutritionals. Three test methods were developed to allow spray chemical phytotoxicity testing using cell cultures, peel disks and whole fruit. Cell suspension cultures initiated from 'nucellar derived' embryonic callus of 'Hamlin' sweet orange and 2) peel disks of orange or grapefruit were grown in culture and exposed to media incorporated test chemicals. Reduced weight gain (Method 1) or color changes and callus growth reduction (Method 2) were used to evaluate phytotoxicity. Dilute sprays and droplet applications to on-tree fruit (Method 3) were used to evaluate individual and combinations of chemicals with and without spray adjuvants. The three tests effectively determined thresholds for phytotoxicity and will be useful for testing new citrus production chemicals. These were preliminary evaluations and could be refined for statistical application. Chemicals tested and found to have some level of phytotoxicity by these methods included Aliette, Morestan, Pro-Gibb with 2,4-D, citric, phosphorus, and phosphoric acids, and some additional pesticides in combination with urea. Two herbicide grade adjuvants tested (Herbex and Induce) increased phytotoxicity in on-tree tests. Salty water often reduced the influence of a surfactant. Acidity, in itself, was phytotoxic to the peel of the fruit indicating buffering is important to minimize spray burn.**

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Citrus in Florida often develops spray burn injury. This is particularly true for grapefruit in the Indian River area. The cause of greater susceptibility of Indian River grapefruit is not known but may be related to higher absorption due to high humidity, ideal temperatures and thinner cuticles on the fruit. Tank mixing often creates mixtures with more than one phytotoxic chemical which probably increases spray injury. In addition, growers have been using adjuvants to enhance effectiveness of chemicals, but tank mixtures often include materials that are meant to be contact/surface-