DOWNLOAD PDF CHEMICAL BASIS OF BROMOXYNIL SELECTIVITY BETWEEN WHEAT AND FIDDLENECK

Chapter 1 : UC IPM: Information about Integrated Weed Management in Small Grains

The selectivity of bromoxynil in wheat and fiddleneck was 4. 9 percent of the selectivity existing between wheat and fiddleneck (dry weight basis) of wheat (a.

George Levitt was the leader of the discovery group that made this important discovery originally in First commercial herbicide was chlorsulfuron in small grains First commercial entry in Iowa was chlorimuron-ethyl in soybeans First herbicide family with very high specific activity: Toxic target in plant very facile, changeable between species allowing very different crop and weed specificity changes with minor changes on core sulfonylurea molecule s: For this reason possible to develop sulfonylurea herbicide for every cropping and weed control situation. Applied preemergence, postemergence, etc. Control of problem dicot perennial weeds such as Canada Thistle. Below is Randy Thornhill looking over his rapeseed plants, and some corn seedlings he is testing for corn hybrid cultivar differences in response to primisulfuron: Physiology and Metabolism Mode of Sulfonylurea Action Mode of action is inhibition of acetolactate synthase ALSase enzyme also known as acetohydroxyacid synthase: ALSase is key enzyme in branched amino acid i. There are other, chemically different herbicide families with the same mode of action ALSase inhibition as the sulfonylureas: Inhibition of ALSase caused very rapid cessation of growth, meristems inhibited in susceptible species: Little effect on seed germination. Seedlings often emerge and symptoms develop later. Mode of Sulfonylurea Lethality Plants die due to starvation for needed proteins in new growth because they cannot form these needed proteins without the amino acids valine, leucine, isoleucine. Uptake and Movement of Sulfonylureas in plants Most herbicide members of family readily taken up by foliar and root plant parts. Usually observe ambi-mobile translocation patterns in plants: Site of uptake whether either root or shoot critical to pattern of movement and distribution in plant subsequent to uptake. Rapidly translocate to areas of active growth, e. Basis of Selectivity between Plant Species Selectivity arises from both metabolic and binding site alteration mechanisms that confer sulfonylurea resistance to plants. These weeds also were found to have a high degree of resistance to other herbicide families. ALSase resistant soybeans, imidazolinone resistant corn with high degree of cross resistance to sulfonylureas -Cross resistance between sulfonylurea and imidazolinone herbicides is often quite similar in a species, but differences do exist Weeds. Continuous use of sulfonylurea herbicides, especially those with long soil residuals, will select out the susceptible members and leaving only resistant types in as little as 3 years Fate of Sulfonylureas in the Environment Soil Wide range of persistence in the soil environment in family: Both microbial and chemical mechanisms are involved in the degradation of sulfonylurea herbicides in the soil. Degradation or chlorimuron is not accomplished to any significant extent by light, photolysis. Air Sulfonylurea herbicides have, in general, low volatility and as such aerial drift off-target is not a significant environmental threat. At the present time it has not been observed in any groundwater source. Animal Toxicology Sulfonylureas herbicides have relatively low toxicities to animals, including humans. They are apparently one of the safer herbicides to use from this perspective. Plant Injury Symptomology of Sulfonylureas in Plants Chlorosis, necrosis, terminal bud and meristem death below. The first symptom is cessation of growth, stunting. Then chlorosis slowly develops. Why does this picture look so darn familiar? The pattern of injury is a function of the site of uptake: Compared to shoot uptake with the new, young, leaves chlorotic with postemergence applications below: Annual susceptible species turn yellow within days and death of the apical meristem follows. Often a purple coloration associated with the veins is observed in this process below:

Chapter 2 : Herbicide - Wikipedia

ature on bromoxynil phytotoxicity in fiddleneck and h) further eluci- date the reason(s) for selectivity and the mode of action of bromoxy- nil in wheat and fiddleneck.

Develop and demonstrate Best Management Practices, including the use of herbicides combined with herbicide-resistant wheat cultivars for jointed goatgrass Aegilops cylindrica Host control in winter wheat. Formulate a management program for corn and companion rotational crops to control wild proso millet Panicum miliaceum L. Test candidate herbicides under intermountain conditions and provide evidence of efficacy, safety, and other characteristics pursuant to their registration in Utah. The following procedures are proposed to initiate investigations of biological control for squarrose and spotted knapweed and leafy spurge: It is proposed that new corn-growing strategies be evaluated, such as variable tillage techniques, the use of mulches to limit weed seed germination, the use of highly specific chemicals such as isoxaflutole, dimethenamid, and acetachlor, and the use of genetically-modified, herbicide-resistant, Roundup-ready corn hybrids. These strategies can be used in a comprehensive pest control approach in corn rotations. The objective is to determine the performance of herbicides against the common field crop weeds. Further, we must provide efficacy, safety, and environmental impact data prior to receiving federal clearance to allow the new herbicides to be used in Utah. Experience has demonstrated that chemicals behave differently as they are used in different climates and with altered agronomic procedures. These include; a substituting a suitable dicot crop like safflower, together with its weed fighting agronomic technologies, into the winter wheat-fallow rotations and, b adopting new advanced breeding winter wheat cultivars that can be treated with highly potent selective herbicides to kill annual grass weeds. Safflower draws upon soil moisture and fertility not used by wheat and can be grown immediately after wheat in the rotation to provide an additional cash crop which makes this rotation especially attractive to wheat producers. Twenty percent or more of winter wheat producers in Utah have adopted this rotation wherever jointed goatgrass is prevalent. This practice is quickly becoming the number one strategy against this and other weedy grasses. Several herbicide studies in Northern Utah in demonstrate the excellent control potential of persistent weeds in corn and cereal crops. Formasulfuron provided good control of bristly foxtail in silage corn but was weak on common lambsquarters early-on in the season. By mid-season of the crop, control was excellent for both weeds. All treatments showed some regrowth of both weeds by harvest. Adjuvants and tank mixes with other herbicides increased early control of lambsquarters but not of bristly foxtail. All treatments except fenoxaprop alone and tank-mixed with tralkoxydim improved wild oat control to nearly percent at harvest. Yields were not significantly different among the wild oat treatments. Impacts The potential savings to Utah agriculture through jointed goatgrass management is approximately five million dollars annually. Conservative estimates put annual yield and quality losses in agronomic crops alone, due to weeds in Utah, at over 30 million dollars. Photosynthetic and growth responses of Zeamays L and four weed species following post-emergence treatments with mesotrione and atrazine. Pest Manag Sci Performance of postemergence wild proso millet herbicides in field corn. Evaluation of kochia control in winter wheat. Evaluation of herbicides for wild buckwheat control in spring wheat. The rust spreads by itself to areas where dyers woad has become an invading species and threatens to displace more desirable plant species. Infection levels of P. Rust infection on the weed does not appear to be negatively affected by an occasional application of auxinic herbicides to dyers woad plants that escaped infection. The third year of a five-year jointed goatgrass study verified the positive effect of inserting a spring dicot crop into a winter wheat-fallow rotation. Safflower uses deep moisture not used by wheat and can be grown immediately after wheat in the rotation to provide an additional cash crop. This substitution provides opportunity to use jointed goatgrass-eliminating herbicides in the rotation. When a herbicide-resistant wheat, CV, was substituted for the traditional wheat in the rotation, any remaining goatgrass plants in the wheat were removed with imazomox. Economic estimates reveal that growers will not be penalized by the alternative rotation due to recovered yields of wheat and one additional safflower crop during a six-year interval. A five-year tillage study revealed that precipitation patterns have greater impacts on jointed goatgrass numbers in either the fallow season or in winter wheat than does post-harvest tillage timing. Wild proso millet continues to spread and threatens all corn growing areas in Utah. Herbicide studies in in Utah, demonstrated excellent wild proso millet control without silage corn injury if treatments are properly applied. Formasulfuron alone and in combination with diflufenzopyr, mesotrione, atrazine, dimethenamid, and acetochlor all gave season-long wild proso millet control to harvest. Nicosulfuron combined with diflufenzopyr also provided excellent proso millet in corn throughout the season. Kochia has become a greater concern as some species have developed resistance to several sulfonylurea and related wheat herbicides. Resistance was not confirmed. No treatments injured wheat. Wild buckwheat control was excellent with all treatments except fenoxaprop. Excellent prickly lettuce control was maintained through July by all treatments. Common lambsquarters was held in check with all treatments except quinclorac. Impacts Some National leaders have said in effect, that the invasion of exotic plant and animals species is the greatest threat to the preservation and diversity of our national ecosystems. Invasive weeds also top the list of challenges to economic and sustainable farm production of food and fiber in the United States. New pendimethalin formulations and combinations for broadleaf weed control in silage corn. Annual weed control in silage corn. Annual weed control in field corn with postemergence mesotrione. Annual weed control in field corn with preemergence mesotrione. Rotational crop response following meostrione application in field corn. Photosynthetic response of five plant species to postemergence mesotrione and atrazine.. Weed control programs in field corn with mesotrione applied preemergence. Evaluation of wild oat herbicides for spring wheat. Evaluation of fenoxaprop for wild oat and wild buckwheat control in spring wheat. Surveys of infestations of this weed reveal that the rust Puccinia thlaspeos has naturally spread to every location threatened by the weed. A demonstration of best management practices to control jointed goatgrass in winter wheat was established at Blue Creek, UT in and the first crops were harvested that year. Yields of the traditional wheat variety, herbicide-resistant wheat variety, and safflower were at or above the local production averages for these crops and established baselines against which future crop responses can be measured. For the treatments not in the fallow phase of the rotation in , both the traditional wheat and the herbicide-resistant wheat yields were not different than yields of weed-free wheat. The impact of safflower in the rotation on the presence of jointed goatgrass in subsequent wheat crops was first measurable in and revealed more than 75 percent decrease in the weed population. Extensive research on isoxaflutole has revealed that it causes severe injury to corn under some circumstances and, as a result, mesotrione with a similar mode of action shows promise as a suitable replacement. Field trials established at four locations in northern Utah in included preemergence and postemergence mesotrione applications. Minor injury was observed initially on some corn plants but was not evident 25 days after treatment. Mesotrione showed good to excellent control of common lambsquarters Chenopodium album , redroot pigweed Amaranthus retroflexus , and velvetleaf Abutilon theophrasti. Mesotrione was noticeably weak on grasses but up to four-fold increases in green foxtail Setaria viridis control were observed when mesotrione was applied in combination with acetochlor, dimethenamid, pendimethalin, or nicosulfuron while maintaining excellent broadleaf weed control. Propoxycarbazone with the safner mefenpyr or tank mixed with fenoxaprop gave excellent control of wild oat but not wild buckwheat. Fenoxaprop provided excellent wild oat control but not wild buckwheat. Flucarbazone alone or combined with mefenpyr or 2,4-D gave excellent control of these two species. Sulfosulfuron provided acceptable control of wild oat but not wild buckwheat. Pendimenthalin plus dimethenamid and diflufenzopyr plus dicamba controled bristily foxtail in silage corn. Flufenacet did not control velvetleaf nor lambsquarters but did measurably reduce bristily foxtail in field corn. Management implications of glyphosate-resistant wheat Triticum aestivum in the Western United States. Performance of mesotrione for annual weeds in corn under semi-arid conditions of the West. Wetland and wildlife habitat threatened by goatsrue Galega officinalis. Estimating site suitability and potential distribution of invasive weed species in northeastern Utah. Performance of mesotrione for annual weed control in field corn. Grass and broadleaf weed control with imazamox in seedling alfalfa. Broadleaf weed control in silage corn. Performance of postemergence wild proso millet herbicides in field corn with and without preemergence mesotrione. Evaluation of wild oat control herbicides in spring wheat. Rotational crop injury following flucarbazone and sulfosulfuron application to winter wheat. Currently available insects have been introduced for both leafy spurge and squarrose knapweed. The most effective management procedure for winter wheat growers in the Intermountain Region is to rotate from a winter wheat-fallow-winter wheat rotation to a winter wheat-spring crop-fallow regime. Safflower appears to be particularly effective. Second in importance is the use of herbicide-resistant winter wheat cultivars that can be combined with selective herbicides against jointed goatgrass. Somewhat less important management strategies that have measurable jointed goatgrass control potential are earlier planting dates and taller stature wheat. Tillage type and timing appeared to have little effect on jointed goatgrass infestations in succeeding wheat crops. Safflower planted once in a three-year rotation reduced jointed goatgrass tillers in winter wheat from 52 to 86 percent. Yields were 25 percent greater for rotations with safflower as compared to winter wheat alone. Winter wheat yields were 45 percent greater for wheat planted in September as compared to October, and dockage was reduced by 50 percent. AEF in combination with diflufenzopyr, mesotrione, and dimethenamid, as well as diflufenzopyr applied alone, gave excellent control of these two broadleaf weeds in corn. No corn injury occurred with any of these herbicides. Mesotrione is a new natural product herbicide being developed for preemergence and postemergence use in corn. With adequate soil moisture it controlled pigweed and lambsquarters as a preemergence treatment. Postemergence treatments were all satisfactory when adjutants and nitrogen were added to the treatment. Mesotrione was weak on grassy weeds in corn. Flucarbazone and sulfosulfuron applied in the fall injured sugar beets, alfalfa, canola, and barley when these crops were planted in the spring.

Chapter 3 : CULTURAL, BIOLOGICAL AND CHEMICAL CONTROL OF WEEDS IN FIELD CROPS - UTAI

Penetration of bromoxynil into leaf surfaces of winter wheat, a resistant species, and coast fiddleneck (Amsinckia intermedia), a susceptible species, and retention of the spray solution by these plants were studied under controlled conditions.

I am pleased to announce that the Environmental Protection Agency has completed its reregistration eligibility review and decisions on the pesticide chemical case which includes the active ingredients bromoxynil phenol and bromoxynil octanoate. The RED includes the data and labeling requirements for products for reregistration. It also includes requirements for additional data generic on the active ingredient to confirm the risk assessments. To assist you with a proper response, read the enclosed document entitled "Summary of Instructions for Responding to the RED. You must follow all instructions and submit complete and timely responses. The first set of required responses is due 90 days from the receipt of this letter. The second set of required responses is due 8 months from the date of this letter. Complete and timely responses will avoid the Agency taking the enforcement action of suspension against your products. This RED takes into account, to the extent currently possible, the new safety standard set by FQPA for establishing and reassessing tolerances. However, it should be noted that in continuing to make reregistration determinations during the early stages of FQPA implementation, EPA recognizes that it will be necessary to make decisions relating to FQPA before the implementation process is complete. Rather, these early determinations will be made on a case-by-case basis and will not bind EPA as it proceeds with further policy development and any rulemaking that may be required. If you have questions on the product specific data requirements or wish to meet with the Agency, please contact the Special Review and Reregi strati on Division representative Karen Jones Address any questions on required generic data to the Special Review and Reregi strati on Division representative, Linda Werrell If product specific data are required, a DCI letter will be enclosed listing such requirements. If both generic and product specific data are required, a combined Generic and Product Specific DCI letter will be enclosed describing such data. However, if you are an end-use product registrant only and have been granted a generic data exemption GDE by EPA, you are being sent only the product specific response forms 2 forms with the RED. Registrants responsible for generic data are being sent response forms for both generic and product specific data requirements 4 forms. Time extension requests may be submitted only with respect to actual data submissions. Requests for time extensions for product specific data should be submitted in the day response. Requests for data waivers must be submitted as part of the day response. All data waiver and time extension requests must be accompanied by a full justification. All waivers and time extensions must be granted by EPA in order to go into effect. Use only an original application form. Mark it "Application for Reregistration. Five copies of draft labeling which complies with the RED and current regulations and requirements. Submit any other amendments such as formulation changes, or labeling changes not related to reregi strati on separately. You may, but are not required to, delete uses which the RED says are ineligible for reregi strati on. The labeling and CSF which you submit for each product must comply with P. Notice by declaring the active ingredient as the nominal concentration. You have two options for submitting a CSF: A copy of the CSF is enclosed; follow the instructions on its back. Arlington, VA 6. EPA will try to respond to data waiver and time extension requests within 60 days. EPA will also try to respond to all 8-month submissions with a final reregi strati on determination within 14 months after the RED has been issued. Chemical Overview 2 B. Use Profile 2 C. Estimated Usage of Pesticide 4 D. Data Requirements 4 E. Regulatory History 4 III. Physical Chemistry Assessment 6 B. Human Health Assessment 7 1. Toxicology Assessment 7 a. Acute Toxicity 7 b. Subchronic Toxicity 8 c. Chronic Toxicity and Carcinogenicity 12 d. Developmental Toxicity 15 e. Reproductive Toxicity 20 f. Dermal Penetration 27 k. Other Toxic Endpoints 28 1. Toxicity Equivalence 29 m. Dose-Response Assessment 29 n. Toxicological Endpoints for Risk Assessmen 32 2. Exposure Assessment and Risk Assessment 35 a. Dietary Exposure - Food Sources 35 b. Dietary food sources Risk Characterization 44 c. Dietary Exposure - Drinking Water 46 d. Aggregate Risk 49 e. Cummulative Risk 50 3. Occupational Exposure and Risk Characterization 51 a. Handler Exposures and Risk 51 b. Postapplication Exposures and Risk 65 c. Epidemiological Information 66 C. Environmental Assessment 67 1. Ecological Toxicity Data 67 a. Toxicity to Terrestrial Animals 67 b. Toxicity to Aquatic Animals 69 e. Toxicity to Plants 71 2. Environmental Fate 73 a. Environmental Fate Assessment 73 b. Environmental Fate and Transport 74 c. Water Resources 78 3. Exposure and Risk Characterization 87 a. Ecological Exposure and Risk Characterization 87 b. Environmental Risk Characterization IV. Determination of Eligibility 1. Eligibility Decision 2. Eligible and Ineligible Use B. Regulatory Position 1. Tolerance Reassessment 2. Summary of Risk Management Decisions Ill a. Human Health Ill b. Restricted Use Classification d. Reference Dose Exceedance e. Endangered Species Statement f. Labeling Rationale g. Spray Drift Advisory h. Other Labeling Requirements V. Manufacturing-Use Products 1. Additional Generic Data Requirements 2. Labeling Requirements for Manufacturing-Use Products a. Formulation Statements b. Plantback Intervals B. End-Use Products 1. Additional Product-Specific Data Requirements 2. Labeling Requirements for End-Use Products a. Entry Restrictions 3. Products Intended Primarily for Occupational Use a. WPS Uses b. Non-WPS Uses 4.

Chapter 4 : Fact Sheet: Reregistration Eligibility Decision (RED): Bromoxynil

Bromoxynil is a selective contact foliage applied herbicide used to control a variety of grasses and broadleaf weeds. and broadleaf weeds on wheat and barley.

Although it is usually applied as the octanoate ester, the ester hydrolyzes rapidly to bromoxynil. Bromoxynil may also be released as runoff from fields treated with bromoxynil and enter waterways. However, high concentrations appear to occur during rain events within two months of application. Bromoxynil is discharged into the atmosphere as an aerosol during spraying operations and will be removed by gravitational settling and photolysis. If sprayed on fields, bromoxynil will photolyze on the soil surface and biodegrade. It is expected to adsorb moderately to soil at neutral and alkaline pHs. In field studies, bromoxynil was completely dissipated from soil in 10 wks when applied in May and 15 wks when applied in December. No bromoxynil residues were found in lower layers of soil. If released into water, bromoxynil will photolyze in surface layers of water and biodegrade. In test ponds, bromoxynil did not persist in sediment beyond 15 days after treatment. It should not bioconcentrate in aquatic organisms. Exposure to bromoxynil will be primarily occupational. Agricultural workers may be exposed by inhalation and dermal contact during spraying, mixing, and cleanup operations and by touching soil and plants to which bromoxynil was applied. No evidence of residual problems when applied at the rate of 0. If sprayed on fields bromoxynil will photolyze on the surface and biodegrade. It should adsorb moderately to soil at low pHs, not at neutral or higher pHs. Commercial formulations of bromoxynil were applied to field plots containing heavy clay or sandy loam soil in May for two consecutive years and the soil sampled 10 weeks after application. No bromoxynil residues were found at either the or cm soil depths. On test winter wheat field plots treated with bromoxynil octanoate in December, concn of bromoxynil and bromoxynil octanoate averaged 0. After days, trace amounts of bromoxynil and no ester remained in the upper 7 cm of soil and neither substance was detected between 7 and 21 cm. If released into water, bromoxynil will be partially dissociated at neutral or basic environmental pHs. It will adsorb moderately to sediment and particulate matter at acid pHs. It will photolyze in surface water and biodegrade. In four test ponds sprayed with equal proportions of bromoxynil butyrate and octanoate, bromoxynil was initially detected in the surface cm sediment but did not persist there beyond 15 days after treatment. In the pond water the concentration of the photolysis product of bromoxynil was at similar levels as bromoxynil between 5 and days post-treatment. This suggests that the photolysis half-life was comparable to that of the hydrolysis of the bromoxynil esters, hr. Bromoxynil is discharged into the atmosphere as an aerosol during spraying operations. It will be removed from theair by gravitational settling. Due to its very low vapor pressure, bromoxynil should not occur as a vapor in the atmosphere. Bromoxynil-containing aerosols will undergo photolysis, the rate of which will depend on the solar irradiance and cloud cover. In the laboratory, the photolysis half-life of bromoxynil solutions irradiated with a watt xenon-mercury lamp that was filtered to remove radiation less than nm, was less than 40 min. Commercial bromoxynil is usually formulated as the octanoate ester, potassium salt or butyrate ester The chemical nature of the hydrolysis was apparent from the fact that sodium azide did not impede degradation. In field experiments where bromoxynil butyrate and octanoate esters BB and BO were sprayed on ponds, the half-life of these esters in the surface microlayer was 0. One hour afte test ponds with BO and BB, bromoxynil-phenol was the predominant f bromoxynil in subsurface pond water. The half-life of BB and BO 0. Laboratory-der hydrolysis half-lives for the butyrate and octanoate in unsterile 8. Since hydrolysis of the BB and BO esters are 16 and 62 hr, respectively very slow at pH 7, chemical hydrolysis may contribute to the disappearance of the esters in the pond water. When bromoxynil octanoate was added to clay loam, fen peat, and sand soils, residues declined to below the level of detection after 28, 44 and 14 days, respectively. The partitioning and degradation of a single spray application of a 1: Intensive sampling of two ponds treated at 2. In subsurface waters cm depth the major forms of the herbicide were bromoxynil phenol and its monobromo analog 3-bromohydroxybenzonitrile. Half-lives of the phenol averaged 9. In a survey of farm wells in Ontario, Canada, in and 76 in , bromoxynil was not detected in any wells at a detection limit of 0. However, bromoxynil was only used on crops in only 15 farms in and 6 in Levels of major herbicides were monitored in two rivers draining prairie agricultural watershed in Manitoba, Canada, the Ochre and Turtle, during The Ochre drains mostly non-cropped land and forest and the Turtle drains mainly agricultural land. Bromoxynil residues were observed in the Turtle river following the major high water event in late June , but only at very low levels at other times. The monthly avg concn of bromoxynil in the Ochre River from April to December ranged from For the Turtle River, the concn ranged from 0. This pattern indicates that the source of bromoxynil is field runoff. The yearly surface lossesof bromoxynil through runoff of 1. Although the herbicide was applied as the octanoate ester, no ester was detected in the runoff. The concn of a herbicide in runoff water will depend on how soon after application it rained and how much rain fell. In test plots on which rain fell six days after application, the concn of bromoxynil ranged from 0.

Chapter 5 : Selectivity of bromoxynil in a resistant and a susceptible species.

On test winter wheat field plots treated with bromoxynil octanoate in December, concn of bromoxynil and bromoxynil octanoate averaged and umol/kg, respectively 24 hr after treatment. After days, trace amounts of bromoxynil and no ester remained in the upper 7 cm of soil and neither substance was detected between 7 and 21 cm.

Weed photo gallery Weeds compete with small grains barley, oats, wheat, rye, and triticale for nutrients, water, and light, reducing crop yields and grain quality. An integrated weed management program in small grains combines cultural, mechanical, and chemical weed control practices. A vigorous, competitive crop produced through good cultural practices is the best defense against weed competition. Several herbicides are available for use in grain; however, one should rely on an integrated approach to weed management. An integrated approach is all inclusive, using good cultural practices and crop rotation along with the appropriate herbicides. The variety of environments and production systems in California requires several different strategies for weed control. Grain is grown under irrigated and dryland conditions in California. These different cultural and climatic conditions have considerable impact on weed management. Where annual rainfall is less than 18 inches, dryland management may include a rotation into summer fallow to conserve moisture and to reduce weed problems. In irrigated fields, the grower has more options to manage weed problems within a rotational system. A good pictorial reference, such as the online weed gallery photos on the UC IPM website will help assist in identifying weeds. It is important to keep a log of summer and winter weeds by field for a comprehensive management system. Examine the grain field when the crop is in the 2- to 3-leaf stage so weeds can be detected easily. The entire field should be examined to determine which species of weeds are present. Visualize a square yard area and count the number of weeds, identifying species and size. Make frequent counts as you walk through the field to get a realistic picture of the problem. Five or more competitive weeds e. Thoroughly cleaning combines and tillage equipment before entering or leaving a field is an important practice. Seed certified by the California Crop Improvement Association is slightly more expensive than common seed, but is a good investment to ensure potential for higher yield, increased germination, and reduced risk of introducing a new weed species. A few weed seeds planted with grain seed can contaminate a sizable area within a few years. Wild oats, ripgut brome, and field bindweed are often spread as contaminants in common seed. Crop rotation helps manage weeds johnsongrass, wild oats, ryegrass, etc. Crops other than grain may be more competitive with certain weeds. For example, corn or dry beans can cover and shade the rows during summer, helping to compete with annual weeds. Cotton, corn, alfalfa, potato, sugarbeet, dry beans, tomato, and safflower are among the crops grown in rotation with grains. Fallow also encourages microbial activity, releasing essential elements from decomposing cereal stubble. A grower usually needs to till during fallow to control weeds. In conservation tillage farming or in fields severely infested with weeds, a grower will need to use herbicides during fallow, a practice called chemical fallow. In arid regions, such as the Imperial and San Joaquin Valleys, cereal growers often preirrigate or wait for the first rain to germinate weed seeds and remove them by tilling before planting or by applying postemergent herbicides such as glyphosate Roundup or paraquat Gramoxone. In spring-planted areas, fall preirrigation is practiced to germinate wild oats and volunteer grains; however, in high rainfall areas or in heavy soils, preirrigated fields remain too wet for timely planting of the crop. Adequate drainage is essential for fields planted to small grains. Excessive moisture in low areas creates and aggravates problems, such as stand loss, loss of soil nutrients, reduced oxygen supply, and root diseases. Chiseling the soil before seedbed preparation greatly enhances drainage and root development. Growing grain on beds in the Sacramento and San Joaquin Valleys has a two-fold advantage: In the Delta where grain is grown on organic soils, spud ditches are used for this same purpose. In areas where flooding and high water tables occur, grow small grains on 30 to 60 inch raised beds. Tillage practices vary widely in California. Tillage is used to eliminate existing weeds, incorporate residues and fertilizer, reduce compaction, and prepare a seedbed. It includes chiseling, disking, plowing, and harrowing to firm the seedbed before planting. Plowing the soil 12 to 14 inches reduces the risk of herbicide carryover from the previous crop. Dilution of possible residuals of herbicides applied to previous crops is very important if grains are planted after cotton, sugarbeet, dry beans, tomato, alfalfa, corn, potato, lettuce Imperial Valley , or oil seed crops. Under dryland conditions, primary fall tillage with a disk, chisel plow, or moldboard plow, usually follows as soon after the first autumn rainfall to eliminate germinating winter weed seedlings. Planting methods and seeding rates. Small grains are either planted with a grain drill or broadcast and incorporated to a depth not to exceed 2 inches. Drilled grain generally produces a more uniform stand than broadcast planting. Sowing date can influence weed competition. Grains planted late are shorter, produce fewer tillers, and are less competitive with weeds than grains planted at the recommended time. Plant late-planted wheat at higher seeding rates to improve yield and weed competitiveness. In many areas high seeding rates of wheat lb per acre are used as a form of weed control to compete with johnsongrass, smartweed, and wild oats. Excessive seed rates in barley and oats increase lodging and diseases. An effective means of weed control used in the southern desert is mulch planting. Mulch planting places the seed beneath a layer of dry mulch, which inhibits weed seed germination. Before planting, the field is shallowly cultivated to destroy weeds that have germinated following a rainfall or irrigation. The crop is then sown into moist soil below the mulch layer of dry soil that resulted from the cultivation. Because the crop seed is placed into moist soil, it germinated quickly, ahead of weeds. In some cases this method eliminates the need for herbicides. Proper amounts of nitrogen and phosphorous are critical in managing crop yield and its ability to compete with weeds. Grain fields low in nitrogen and phosphate are not vigorous, giving weeds the advantage. Anytime a fertilizer is broadcast, weeds benefit more than the crop. Banding of fertilizers in or near the crop seed row will make fertilizer more available to the crop during the seedling stage than to weeds. This is particularly advantageous with phosphate applications. Weeds that have germinated can be chemically removed with paraquat or glyphosate before planting or before crop emergence. Pyraflufen-ethyl ET is also labeled for control of emerged broadleaves. These nonselective herbicides have no soil residual effects on germinating small grain plants as long as they are applied before the plants emerge through the soil. If the herbicide comes into contact with wheat and barley plants, severe injury will occur. Glyphosate also can be a tool at this time to suppress perennial weeds such as johnsongrass, nutsedge, bermudagrass and dandelion. Preemergent herbicides are not commonly used in small grains in California but can be effective in certain situations. Trifluralin Treflan is a preemergent herbicide used for wild oat and canarygrass control in wheat and barley. It is applied before or after sowing and must be incorporated no deeper than 2 inches. A double incorporation is more effective than a single incorporation. Small grains must be planted below the 2-inch herbicide zone for semi-dwarf wheat, this depth is near the limit for successful emergence. Results can be erratic if the zone of treatment does not have adequate moisture. Crop safety is marginal. Cultivation is not possible and producers must rely on herbicides and good agronomic practices for effective control. Depending upon the amount of rainfall after planting, one to three nitrogen top dressings may be required for wheat. Postemergent herbicides are applied to the crop, usually at the 2- to 3-leaf and tillered stages. Fall-planted grains are treated between December to mid-March, depending on time of planting and on growing conditions. Generally, spring-planted grains at higher elevations are treated from April to June. Depending on weeds present, one or two herbicide applications or combinations may be required. Application must be properly timed for maximum weed control and avoidance of crop injury. Grass and broadleaf weeds germinate with the beginning of the rainy season. Depending upon species, they can sometimes be controlled at the same time, permitting the use of tank-mixed herbicide combinations, but often grass and broadleaf control need separate applications. A tank mix can mean an important savings of time and cost. Refer to herbicide labels for mixing recommendations. Typically only postemergent herbicides are applied after the crop has emerged. Fall-sown small grains usually are treated between December and mid-March, depending on the sowing date and growing conditions. Spring-sown small grains in the intermountain area of northern California are treated between April and June. Several postemergent herbicides are registered for use. Phenoxy herbicides, including

2,4-D and MCPA, commonly are used in small grains alone or in combinations. Dicamba, another hormonal-type herbicide, often is included in the phenoxy herbicide group because of its similar mode of action. These herbicides are most effective when applied to small and succulent weeds. Small grains vary in their sensitivity to these herbicides; for example, oat is more tolerant to MCPA than to 2,4-D. Ester and amine formulations of 2,4-D and MCPA control many broadleaf weed species encountered in small grains. The ester form usually is more effective than the amine form. However, ester use is not permitted in most counties or applications are limited to certain times of the year. Best control is obtained when weeds are small and before the crop has reached the jointing stage. Late applications are sometimes ineffective because the crop canopy shields the weeds, preventing herbicide contact. The use of aircraft often facilitates timely herbicide application, but care must be taken to make applications at the appropriate time to avoid injury to adjacent crops from drift or volatilization. MCPA does not control large weeds as well as 2,4-D amine and 2,4-D ester herbicides but has greater crop safety especially when applied to small grains in early growth stages.

Chapter 6 : Spectrum Laboratories : Chemical Fact Sheet - Cas # CASRN

A chemical formula is a way of expressing information about the proportions of atoms that constitute a particular chemical compound, using a single line of chemical element symbols and numbers.

History[edit] Prior to the widespread use of chemical herbicides, cultural controls , such as altering soil pH, salinity, or fertility levels, were used to control weeds. Although research into chemical herbicides began in the early 20th century, the first major breakthrough was the result of research conducted in both the UK and the US during the Second World War into the potential use of herbicides in war. Templeman at Imperial Chemical Industries. In , he showed that "Growth substances applied appropriately would kill certain broad-leaved weeds in cereals without harming the crops. In the same year, Pokorny in the US achieved this as well. By analyzing soil as a dynamic system, rather than an inert substance, he was able to apply techniques such as perfusion. Quastel was able to quantify the influence of various plant hormones, inhibitors and other chemicals on the activity of microorganisms in the soil and assess their direct impact on plant growth. While the full work of the unit remained secret, certain discoveries were developed for commercial use after the war, including the 2,4-D compound. It allowed for greatly enhanced weed control in wheat , maize corn , rice , and similar cereal grass crops, because it kills dicots broadleaf plants , but not most monocots grasses. The low cost of 2,4-D has led to continued usage today, and it remains one of the most commonly used herbicides in the world. Like other acid herbicides, current formulations use either an amine salt often trimethylamine or one of many esters of the parent compound. These are easier to handle than the acid. Further discoveries[edit] The triazine family of herbicides, which includes atrazine , were introduced in the s; they have the current distinction of being the herbicide family of greatest concern regarding groundwater contamination. Atrazine does not break down readily within a few weeks after being applied to soils of above neutral pH. Under alkaline soil conditions, atrazine may be carried into the soil profile as far as the water table by soil water following rainfall causing the aforementioned contamination. Atrazine is thus said to have "carryover", a generally undesirable property for herbicides. Glyphosate Roundup was introduced in for nonselective weed control. Following the development of glyphosate-resistant crop plants, it is now used very extensively for selective weed control in growing crops. The pairing of the herbicide with the resistant seed contributed to the consolidation of the seed and chemistry industry in the late s. Many modern chemical herbicides used in agriculture and gardening are specifically formulated to decompose within a short period after application. This is desirable, as it allows crops and plants to be planted afterwards, which could otherwise be affected by the herbicide. However, herbicides with low residual activity i. This gives rise to a considerable level of terminology related to herbicides and their use. Intended outcome[edit] Control is the destruction of unwanted weeds, or the damage of them to the point where they are no longer competitive with the crop. Suppression is incomplete control still providing some economic benefit, such as reduced competition with the crop. Crop safety, for selective herbicides, is the relative absence of damage or stress to the crop. Most selective herbicides cause some visible stress to crop plants. Defoliant , similar to herbicides, but designed to remove foliage leaves rather than kill the plant. Selectivity all plants or specific plants [edit] Selective herbicides control or suppress certain plants without affecting the growth of other plants species. Selectivity may be due to translocation, differential absorption, physical morphological or physiological differences between plant species. They are used to clear industrial sites, waste ground, railways and railway embankments. Paraquat, glufosinate, glyphosate are non-selective herbicides. Preplant herbicides are nonselective herbicides applied to soil before planting. Some preplant herbicides may be mechanically incorporated into the soil. The herbicides kill weeds as they grow through the herbicide treated zone. Volatile herbicides have to be incorporated into the soil before planting the pasture. Agricultural crops grown in soil treated with a preplant herbicide include tomatoes, corn, soybeans and strawberries. Soil fumigants like metam-sodium and dazomet are in use as preplant herbicides. Preemergence herbicides are applied before the weed seedlings emerge through the soil surface. Herbicides do not prevent weeds from germinating but they kill weeds as they grow through the herbicide treated zone by affecting the cell division in the emerging seedling. Dithopyr and pendimethalin are preemergence herbicides. Weeds that have already emerged before application or activation are not affected by pre-herbicides as their primary growing point escapes the treatment. These herbicides are applied after weed seedlings have emerged through the soil surface. They can be foliar or root absorbed, selective or nonselective, contact or systemic. Application of these herbicides is avoided during rain because the problem of being washed off to the soil makes it ineffective. Herbicides applied to the soil are usually taken up by the root or shoot of the emerging seedlings and are used as preplant or preemergence treatment. Several factors influence the effectiveness of soil-applied herbicides. Weeds absorb herbicides by both passive and active mechanism. Herbicide adsorption to soil colloids or organic matter often reduces its amount available for weed absorption. Positioning of herbicide in correct layer of soil is very important, which can be achieved mechanically and by rainfall. Herbicides on the soil surface are subjected to several processes that reduce their availability. Volatility and photolysis are two common processes that reduce the availability of herbicides. Many soil applied herbicides are absorbed through plant shoots while they are still underground leading to their death or injury. EPTC and trifluralin are soil applied herbicides. These are applied to portion of the plant above the ground and are absorbed by exposed tissues. These are generally postemergence herbicides and can either be translocated systemic throughout the plant or remain at specific site contact. External barriers of plants like cuticle, waxes, cell wall etc. Glyphosate, 2,4-D and dicamba are foliar applied herbicide. An herbicide is described as having low residual activity if it is neutralized within a short time of application within a few weeks or months - typically this is due to rainfall, or by reactions in the soil. An herbicide described as having high residual activity will remain potent for a long term in the soil. For some compounds, the residual activity can leave the ground almost permanently barren. Mechanism of action[edit] Herbicides are often classified according to their site of action, because as a general rule, herbicides within the same site of action class will produce similar symptoms on susceptible plants. Classification based on site of action of herbicide is comparatively better as herbicide resistance management can be handled more properly and effectively. List of mechanisms found in modern herbicides[edit] ACCase inhibitors: Acetyl coenzyme A carboxylase ACCase is part of the first step of lipid synthesis. Thus, ACCase inhibitors affect cell membrane production in the meristems of the grass plant. These herbicides slowly starve affected plants of these amino acids , which eventually leads to inhibition of DNA synthesis. They affect grasses and dicots alike. The ALS biological pathway exists only in plants and not animals, thus making the ALS-inhibitors among the safest herbicides. Enolpyruvylshikimate 3-phosphate synthase enzyme EPSPS is used in the synthesis of the amino acids tryptophan , phenylalanine and tyrosine. Synthetic auxins inaugurated the era of organic herbicides. They were discovered in the s after a long study of the plant growth regulator auxin. Synthetic auxins mimic this plant hormone. They have several points of action on the cell membrane, and are effective in the control of dicot plants. They bind to the Qb site on the D1 protein, and prevent quinone from binding to this site. Therefore, this group of compounds causes electrons to accumulate on chlorophyll molecules. As a consequence, oxidation reactions in excess of those normally tolerated by the cell occur, and the plant dies. The triazine herbicides including atrazine and urea derivatives diuron are photosystem II inhibitors. As a result, reactive oxygen species are produced and oxidation reactions in excess of those normally tolerated by the cell occur, leading to plant death. If this happens, the plants turn white due to complete loss of chlorophyll, and the plants die. To do this, farmers must know the mode of action for the herbicides they intend to use, but the relatively complex nature of plant biochemistry makes this difficult to determine. Attempts were made to simplify the understanding of herbicide mode of action by developing a classification system that grouped herbicides by mode of action. This information will make it easier to develop educational material that is consistent and effective. Knowing about herbicide chemical family grouping could serve as a short-term strategy for managing resistance to site of action. Most herbicides are applied as water-based sprays using ground equipment. Towed, handheld, and even horse-drawn sprayers are also used. On large areas, herbicides may also at times be applied aerially using helicopters or airplanes, or through irrigation systems known as chemigation. A further method of herbicide application developed around , involves ridding the soil of its active weed seed bank rather than just killing the weed. This can successfully treat annual plants but not perennials. Because most weeds are annuals, their seeds will only survive in soil for a year or two, so this method will be able to destroy such weeds after a few years of herbicide application. This allows treatment of taller grassland weeds by direct contact without affecting related but desirable shorter plants in the grassland sward beneath. The method has the benefit of avoiding spray drift. In Wales , a scheme offering free weed-wiper hire was launched in in an effort to reduce the levels of MCPA in water courses. Sometimes, the wrong field or plants may be sprayed due to error. Use politically, militarily, and in conflict[edit].

Chapter 7 : Phases of herbicide metabolism - Herbicide Resistance

The structures of bromoxynil, its octanoic and heptanoic acid esters, and its maj or metabolites are presented in Figure A. Figure A. Bromoxynil, its octanoic and heptanoic acid esters, and metabolites Common Name/Chemical Name Bromoxynil phenol 3,5-dibromohydroxybenzonitrile OH Br J\.Br CN Bromoxynil octanoate O O calendrierdelascience.com CN Bromoxynil.

In evaluating pesticides for reregistration, EPA obtains and reviews a complete set of studies from pesticide producers, describing the human health and environmental effects of each pesticide. EPA then reregisters pesticides that can be used without posing unreasonable risks to human health or the environment. This fact sheet summarizes the information in the RED document for reregistration case , bromoxynil. Agricultural crop use sites include: Bromoxynil is formulated as an emulsifiable concentrate, soluble concentrate, and a gel formulation in water soluble packages. The application rates for crop uses range from 6. There are no residential uses for this herbicide. In , tolerances were established for field and fodder crops, meat, and meat byproducts of cattle, goats, hogs, horses and sheep. When the reregistration case for bromoxynil was opened, case , bromoxynil phenol, butyrate, heptanoate and octanoate were all incorpo- rated. Subsequently, bromoxynil butyrate registrations were voluntarily canceled by the registrant hi due to concerns related to developmental toxicity. Therefore, bromoxynil butyrate is not included as a part of this reregistration decision. To reduce these exposures, the registrant undertook several actions. These included label amendments, development of a new jug to prevent splashing and the supply of gloves included in product packaging. Further changes to the reregistration case came when the registrant decided not to support the heptanoate. However, hi , the registrant applied for a new heptanoate registration, which was g;ranted. Since only those pesticides registered prior to are subject to reregistration, the bromoxynil heptanoate is not considered a reregistration chemical and is not specifically incorporated for this reregistration action. However, there are two products which include both the heptanoate and the octanoate forms of bromoxynil. All esters of the chemical are considered to be lexicologically similar to the phenol and, hi fact, rapid conversion of ithe esters to the phenol occurs hi the environment. The exposure estimates, therefore, incorporate exposure to the octanoate and the heptanoate included hi the two combined labels. The percent crop treated used hi the dietary exposure considers all esters of bromoxynil. This tolerance expired on April 1, On May 13, , the Agency issued a tolerance for cotton use. This document incorporates the information published hi the May 13, Federal Register Notice. Bromoxynil octanoate is Toxicity Categpry E for acute oral and derrnal effects and Toxicity Category El for acute inhalation effects. Bromoxynil phenol has been classified as a Group C, possible human carcinogen. Rapid 1 conversion of the ester forms of the chemical heptanoate and octanoate permit the risk assessment to be based on exposure to the phenol. Bromoxynil is considered to be developmentally toxic. The aggregate dietary risk of cancer to the general population from residues hi food and water, associated with long-term exposure to bromoxynil, was estimated to be 1. The estimated aggregate acute dietary risk, calculated as Margins of Exposure MOE , all exceed 10, Therefore, significant concerns related to acute and chronic dietary exposure are not predicted. For all other tasks, the risks are acceptable for handlers wearing baseline attke. The cancer risk for commercial handlers is 1. The highest cancer risk estimate from these particular scenarios was 1. In addition, to provide an additional margin of safety, EPA has required mixers and loaders to wear a chemical-resistant apron. FQPA Assessment In accordance with the Food Quality Protection Act of , the Agency uses a weight-of-evidence approach to determine whether to retain, reduce, or remove the 10X safety factor required for possible enhanced sensitivity to infants and children. The database for the developmental toxicity of bromoxynil is robust. Developmental effects supernumerary ribs being the most sensitive indicator have been observed hi developmental and reproductive studies. All MOEs calculated exceeded 10, and, therefore, developmental effects to any sub-population are not predicted. Environmental Assessment Environmental Fate Bromoxynil octanoate was found to be chemically and-physically similar to bromoxynil heptanoate. Both esters rapidly degrade to bromoxynil per se. Bromoxynil octanoate is mobile and non-persistent. It dissipates in the environment by abiotic hydrolysis, photolytic degradation, and microbially-mediated metabolism in both the aerobic and anaerobic environments. Bromoxynil octanoate readily hydroly2: The hydrolysis half-life for degradation of bromoxynil octanoate ranges from 1 day up to 34 days. Environmental fate studies indicate that bromoxynil phenol and octanoate should not persist hi surface waters. Also, in the case of one of the technicals, EPA is requiring that acute toxicity information be submitted. In addition, product-specific data including product chemistry and acute toxicity studies, product efficacy data, revised Confidential Statements of Formula CSFs , and revised labeling for reregistration are being requested in this document. Additionally, in order to allow moire precise estimates of exposure to bromoxynil in drinking water, the Agency herein reiterates the requirement of the submission of an acceptable surface water monitoring program as specified in the FR Notice, 63FR Product Labeling 1 Plantback intervals. Pending receipt of limited field rotational crop Changes Required studies for cotton, labels must restrict rotation of treated cotton fields, treated with more than 0. The exemption in the Worker Protection Standard for certified crop advisors does not apply to bromoxynil. Scouts and crop advisors are prohibited from entering the treated area during the entire 4-day REI for bromoxynil. Applicators and other users must inform crop advisors and scouts of this requirement. EPA believes that measures to reduce short- and intermediate- term risks also will reduce cancer risks. These REIs reconfirm the REIs of 4 days for cotton and 26 days for sod established in the Federal Register Notice published May 13,, in conjunction with the cotton use registration action. Regulatory Based on the reviews of the generic data for the active ingredient Conclusion bromoxynil, the Agency has sufficient information on the health effects of bromoxynil and on its potential for causing adverse effects hi fish and wildlife and the environment. The Agency has determined that bromoxynil products, labeled and used as specified in the Reregistration Eligibility Decision, will not pose unreasonable risks to humans or the environment. Therefore, the Agency concludes that products containing bromoxynil for all uses are eligible for reregistration, provided the registrant follows all requirements as set forth in the RED. Electronic copies of the RED and this fact sheet are available on the internet. For information about the health effects of pesticides, or for assistance in recognizing and managing pesticide poisoning symptoms, please contact the National Pesticides Telecommunications Network NPTN. Call toll-free , between 9:

Chapter 8 : Reregistration Eligibility Decision (RED) Bromoxynil

This product is for selective post-emergence control of certain broadleaf weeds in wheat (including durum), barley, oat, triticale, post-harvest burndown, pre-plant burndown, fallow, corn and soybeans.

In the case of the bioherbicide bialaphos, a tripeptide obtained from Streptomyces, metabolic cleavage results in the release of glufosinate, which is an important herbicide in its own right. Interestingly, resistance to the herbicide triallate in a biotype of Avena fatua has been demonstrated to be due to a reduced ability to convert triallate to the phytotoxic product triallate sulphox-ide. This is the only reported instance of resistance being due to an inability of a weed to bioactivate a herbicide. Indeed, crude extracts from black-grass plants were more active in ester hydrolysis than wheat. They purified a 45 kDa esterase from wheat that could bioactivate bromoxynil octanoate, but showed no activity towards diclofop-methyl. Conversely, esterase activity towards diclofop-methyl was higher in the weed than the crop. Their observations support the rapid bioactivation by ester hydrolysis of graminicides in grass weeds, contributing to their selectivity. The location of this esterase activity is thought to be the cell wall. The most common way in which plants attack herbicides is by hydroxylation of aromatic rings or of alkyl groups by a family of enzymes known as the cytochrome P mono- or mixed function oxidases Ps. The Ps are a very large family of enzymes now thought to be the largest family of enzymatic proteins in higher plants. They all have a haem porphyrin ring containing iron at a catalytic centre. These enzymes are responsible for the oxygenation of hydrophobic molecules, including herbicides, to produce a more reactive and hydrophilic product. One atom from molecular oxygen is incorporated into the substrate R , while the other is reduced to form water: The enzymes are located on the cytoplasmic side of the endoplasmic reticulum and are anchored by their N-terminus Figure 4. They are found in all plant cells but in very low abundance. This, coupled with their lability in vitro, has meant that they are difficult to study biochemically. All Ps have a highly conserved region of 10 amino acids surrounding the haem group and it is this region that is responsible for the binding of O2, its activation and the transfer of protons to form water. The rest of the P amino acid sequences are highly variable and this probably explains the wide variety of reactions and substrate specificity shown by this enzyme superfamily. This inhibition by carbon monoxide is typically overcome by light. These features are all used in setting criteria for the involvement of P enzymes in herbicide metabolism. The P proteins are between 45 and 62 kDa in size. While their amino acid sequences may vary considerably, their three-dimensional structure is highly conserved, especially in the haem-binding region. The haem binds to the protein at a cysteine residue and the flanking sequence Figure 4. In both haem- and oxygen-binding sequences, X denotes any other amino acid. When these conserved sequences were used to study Ps in plants, a surprisingly large number and diversity of Ps was found. Indeed, more than plant P genes are now known in over 50 families, indicating that the Ps are the largest group of plant proteins. The precise roles of the proteins encoded by these genes is, however, largely unknown. A nomenclature has been designed for P genes based on the identity of the amino acid sequences of the proteins they encode Figure 4. The genes have been numbered in chronological order depending on their date of submission to the P nomenclature committee http: The discovery of new P genes continues in plants. In contrast, only about 50 P genes in 17 families have been described in humans. So why are there so many Ps in plants? The answer seems to be that they play a very wide role in plant secondary metabolism. They have been shown to be involved in the biosynthesis and metabolism of a wide variety of compounds, including terpenes, flavonoids, sterols, hormones, lignins, suberin, alkaloids and phytoalexins. They are also induced by pathogen attack, xenobiotics and by light-induced stress, unfavourable osomotic conditions, wounding and infection. It is currently believed that herbicide molecules also fit the active sites of these Ps involved in biosynthesis, suggesting a broad diversity of substrate selectivity. Regarding their roles in herbicide metabolism, much remains to be done to establish substrate specificity and both the molecular and the metabolic regulation of these Gly - Cys - X - Arg - X - Gly - X - X - Phe Figure 4. Such understanding will be invaluable in predicting and elucidating herbicide selectivity, as well as in the discovery and design of new selective herbicides. The main reactions catalysed by Ps are shown in Figure 4. In herbicide metabolism these are hydroxylation and dealkylation, which progresses via a hydroxylation step. Examples of herbicides metabolised by Ps in plant systems include sulfonylureas including primisulfuron, nicosulfuron, prosulfuron, triasulfuron and chlorimuron , substituted ureas chlorotoluron, linuron , chloroacetanilides metolachlor, acetochlor , tria-zolopyrimidines flumetsulam , aryloxyphenoxypropionates diclofop , benzothiadiazoles bentazon and imidazolinones imazethapyr. Selectivity to herbicides can be due to ability of the crop to metabolise herbicides via Ps, an ability that may not be possessed by susceptible weeds. In some cases, however, this metabolism is not enough to prevent crop damage, either because of low rates of P metabolism or phytotoxicity of products produced by these reactions. Crop damage may only be prevented if reactions from Phase II conjugation are successful in carrying out further detoxification. Some Phase I reactions may be catalysed by peroxidases E. They are currently thought to be involved in proline hydroxy-lation, indole acetic acid IAA oxidation and lignification, and have been implicated in the metabolism of aniline compounds produced in the degradation of phenylcarbamate, phenylurea and acylaniline herbicides. This has the effect of both further reducing phytotoxicity and increasing the solubility of the herbicide or its metabolite, which may also serve to target the conjugate to the vacuole. The most widely studied conjugation reaction in relation to herbicide detoxification is that of glutathione conjugation, carried out by the enzyme family glutathione S- transferases GSTs , E. Glutathione is abundant in plants, often exceeding 1 mM concentration in the leaf cell cytoplasm, where it functions as a scavenger of free radicals, protecting photosynthetic cells from oxidative damage. As GSTs are a large group of similar enzymes found in all eukaryotes, differences in the spectrum of GSTs present plays an important role in selectivity of herbicides. GSTs have a range of endogenous functions involving their abilities to detoxify and act as redox buffers. The GSTs are abundant, soluble enzymes of about 50 kDa, each composed of two subu-nits of equal size, containing an active site located in the N-terminus that binds glutathione and is highly conserved in all GSTs. Herbicides and other xenobiotics are bound at the hydrophobic C-terminal half of the subunit. This site varies considerably and accounts for the differing specificity of GSTs towards herbicides. Arabidopsis thaliana has at least 30 distinct GST genes and their nomenclature is complex. The subunits have been classified on the basis of their amino acid sequence and similarities in gene structure. The classes are termed phi F zeta Z , theta T and tau U and are used in conjugation with the species name, for example:

Chapter 9 : Bromoxynil | C7H3Br2NO - PubChem

chemical family as Pursuit and will become a primary herbicide choice for alfalfa growers in years to come. Raptor is a Selective postemergence herbicide that can be applied to seedling alfalfa.