Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/TX-15/0-6733-1		

4. Title and Subtitle	5. Report Date
EVALUATION OF GENERIC AND BRANDED HERBICIDES: TECHNICAL REPORT	October 2012 Published: March 2015
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Jett McFalls, Young-Jae Yi, Ming-Han Li, Scott Senseman, and Beverly Storey	Report 0-6733-1

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Texas A&M Transportation Institute College Station, Texas 77843-3135	11. Contract or Grant No. Project 0-6733

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Texas Department of Transportation Research and Technology Implementation Office 125 E. 11th Street Austin, Texas 78701-2483	Technical Report: June 2011–May 2012
	14. Sponsoring Agency Code

15. Supplementary Notes

Project performed in cooperation with the Texas Department of Transportation and the Federal Highway Administration.
Project Title: Evaluation of Generic and Branded Herbicides
URL: http://tti.tamu.edu/documents/0-6733-1.pdf

16. Abstract

As with other generic brand products in the marketplace, generic herbicides often have a lower initial product cost than their brand-name counterparts. While the purchase price of herbicides is important to TxDOT, it is essential to look at more than just initial costs to determine whether generic or branded products is the best practice. One should consider safety, effectiveness, and application rates/procedures as well as product availability and equipment requirements. This project focused on three herbicides (Roundup PROMAX®, Escort® XP and Transline®) that TxDOT currently uses. The multi-disciplinary research team conducted a literature review, survey of practice, and cost/benefit analysis to determine whether generic herbicides meet equivalent performance, toxicology, environmental impact, and safety requirements as branded herbicides with significant cost-savings. This study found that generic products with the same or similar formulation often proved equivalent to branded products in human/wildlife effects, performance, and equipment requirements. However, the potential lack of quality control was identified as a concern because many of the generic herbicides were produced overseas. The uncertainties of inert ingredients also made assessments of risks and performance unclear. Meanwhile, the cost-saving benefit by using generic products was not proven, particularly for projects requiring a large amount of herbicide. The generic product may have a cheaper price but may not include the same amount and quality of active ingredient as the brand-name product. Therefore, to achieve an equivalent rate of active ingredient, more of the generic material may need to be used, thereby potentially eliminating whatever cost savings was realized at the initial purchase of the generic product. Other concerns identified with generic herbicides include the lack of availability, and lack of diverse discounts offered by branded herbicide manufacturers.

17. Key Words	18. Distribution Statement
Herbicide, Roadside, Generic	No restrictions. This document is available to the public through NTIS: National Technical Information Service Alexandria, Virginia 22312 http://www.ntis.gov

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	64	

EVALUATION OF GENERIC AND BRANDED HERBICIDES: TECHNICAL REPORT

by

Jett McFalls
Assistant Research Scientist
Texas A&M Transportation Institute

Young-Jae Yi
Post-Doctoral Research Associate
Texas A&M Transportation Institute

Ming-Han Li
Associate Research Engineer
Texas A&M Transportation Institute

Scott Senseman
Professor
Texas A&M University, Department of Soil and Crop Sciences

and

Beverly Storey
Associate Research Scientist
Texas A&M Transportation Institute

Report 0-6733-1
Project 0-6733
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Texas Department of Transportation
and the
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October 2012
Published: March 2015

TEXAS A&M TRANSPORTATION INSTITUTE
College Station, Texas 77843-3135

DISCLAIMER

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

ACKNOWLEDGMENTS

This project was conducted in cooperation with TxDOT and FHWA. The authors thank Mr. Dennis Markwardt who served as project director. Special thanks go to project advisors, John Mason, Brad Haugh, and Walter Hambrick, for their knowledge and continued supports.

Finally, we wish to express our appreciation to TxDOT and the FHWA for their financial sponsorship of the project.

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CHAPTER 1:
INTRODUCTION

As with other generic brand products in the marketplace, generic herbicides often have a lower initial product cost than their brand-name counterparts. Herbicide formulations are patented for 17 years with proprietary rights for name, formula, and production. Once the patent expires, the formula becomes available to anyone that wishes to manufacture or distribute the same formulation as the original. Generic product manufacturers can typically offer much lower prices because they do not have to pay for the initial development, testing, and patent fees that make up the majority of costs associated with agricultural chemicals today. While the purchase price of herbicides is important to TxDOT, it is essential to look at more than just initial costs to determine whether using generic or branded products is the best practice. One should consider safety, effectiveness, and application rates/procedures as well as product availability and equipment requirements. This project focused on three herbicides (Roundup PROMAX®, Escort® XP and Transline®) that TxDOT currently uses. The multi-disciplinary research team conducted a literature review, survey of practice, and cost/benefit analysis to determine whether generic herbicides meet equivalent performance, toxicology, environmental impact, and safety requirements as branded herbicides with significant cost savings. This study also discusses on the support that brand-name companies provide to users (TxDOT) in complaint handling and answering environmental questions that may be brought forward by the public or other agencies.

CHAPTER 2:
LITERATURE REVIEW

HERBICIDE EFFECTS ON HUMAN AND WILDLIFE

Any discussion on herbicides must begin with toxicology and the safety of the products for the applicators and general public. The U.S. Environmental Protection Agency/Office of Pesticide Programs (EPA/OPP) assesses the potential risks to humans and wildlife using acute and chronic toxicity. Acute toxicity is commonly measured with the lethal dose (LD) or lethal concentration (LC) that causes death in 50 percent of treated laboratory animals. LD50 reflects the effect of direct exposure through mouth or skin. LC50 indicates the effect of the inhalation through air (for mammals and birds) or water (for fish). Although human health effect is evaluated based on experiments on mammal animals, human and wildlife have different risk classification system (Table 1 and 2). Chronic toxicity indicates potential health effects (e.g., cancer, birth defects, or reproductive toxicity) that may occur at levels of exposure below those that cause death.

Table 1. Human Acute Toxicity Classification.

	High Toxicity (*Danger*)	**Moderate Toxicity (*Warning*)**	**Low Toxicity (*Caution*)**	**Very Low Toxicity (*Caution*)**
Oral LD50	< 50 mg/kg	50~500 mg/kg	500~5,000 mg/kg	> 5,000 mg/kg
Dermal LD50	< 200 mg/kg	200~2,000 mg/kg	2,000~5,000 mg/kg	> 5,000 mg/kg
Inhalation LC50	< 0.05 mg/l	0.05~0.5 mg/l	0.5~2.0 mg/l	> 2.0 mg/l
Eye Effects	Corrosive	Irritation persisting for 7 days	Irritation reversible in 7 days	Minimal effects, gone in 24 hours
Skin Effects	Corrosive	Severe irritation at 72 hours	Moderate irritation at 72 hours	Mild or slight irritation

Table 2. Wildlife Acute Toxicity Classification.

Risk Category	**Mammals**	**Birds**	**Fish or Aquatic Insects**
	Acute Oral or Dermal LD50 (mg/kg)	**Acute Oral LD50 (mg/kg)**	**Acute LC50 (mg/L)**
Practically nontoxic	> 2,000	> 2,000	> 100
Slightly toxic	501 ~ 2,000	501 ~ 2,000	10 ~ 100
Moderately toxic	51 ~ 500	51 ~ 500	1 ~ 10
Highly toxic	10 ~ 50	10 ~ 50	0.1 ~ 1
Very highly toxic	< 10	< 10	< 0.1

The EPA/OPP uses a hazard quotient (HQ) and cancer risk index to assess non-cancer and cancer health risks, respectively. The HQ is calculated by dividing the exposure by the toxicity. The exposure levels vary by exposure scenario (e.g., adults and children eating drift-contaminated garden vegetables or children directly touching drift-contaminated berries or sprayed vegetation). A HQ of 1 or less suggests that exposures are below the level of concern. A HQ is greater than 1 indicates that potential non-cancer health effects may be possible. Cancer risk index estimates the probability of an individual developing cancer over a lifetime. This index is estimated under very conservative conditions, so that actual cancer risk would be much lower (WSDOT 2006a). Cancer risk estimates of less than 1 in 100,000 are within the range considered negligible. Table 3 presents the detailed classification.

Table 3. Human Risk Classification for Average Exposure Scenarios.

Potential Risks and Management Priority	Hazard Quotient (Non-cancer Risk)	Cancer Risk
Negligible	Less than 1	Less than 1 in 100,000
Low	Between 1 and 10	Between 1 in 10,000 and 1 in 100,000
Moderate	Between 10 and 100	Between 4 in 1000 and 1 in 10,000
High	Greater than 100	Greater than 4 in 1000

This section summarizes herbicide effects on human health and wildlife, referring to risk assessments by the Washington Department of Transportation (WSDOT) and USDA Forestry Service. This study focuses on three herbicides currently used in TxDOT vegetation management program: Roundup PROMAX® (glyphosate), Escort® XP (metsulfuron methyl), Transline® (clopyralid).

Glyphosate

Glyphosate is a non-selective herbicide used to control a wide variety of broadleaf weeds and grasses. It prevents the plants from creating certain proteins that are required for plant growth. Glyphosate is the active ingredient in Roundup PROMAX (51.3%), Rodeo® (51.2%), and Aquamaster® (53.5%), which among TxDOT approved herbicides.

Acute toxicity to humans: Glyphosate has a much lower toxicity than other herbicides. The LD50 of pure glyphosate in rats is 4,230 mg/kg, or 5,600 mg/kg (dose per body weight)

(Monsanto 1985). This level is classified as low toxic or the least toxic in the human toxicity classification system.

Some glyphosate-based herbicides are known as eye irritant. EPA (1993) stated that glyphosate is one of the most widely reported causes of illness to workers from pesticides in California. This eye irritating characteristic is mostly attributed to surfactants included in many glyphosate formulations. Surfactants are used to increase the attachment of the chemical to leaves by reducing the surface tension of liquids. While the toxicity of surfactants used in glyphosate products tends to be as low as those commonly used in shampoos, some surfactants are more toxic than glyphosate, such as POEA (polyoxy-ethyleneamine) (EPA 1993). TxDOT approves uses of Roundup PROMAX among many glyphosate products. We could not find any case that the product cause severe eye damage.

The acute toxicity of selected glyphosate products to humans can be summarized as follows:

- Oral LD50: Low or very low toxicity (caution).
- Dermal LD50: Very low toxicity (caution).
- Inhalation LC50: Very low toxicity (caution).
- Eye effects: Low or very low toxicity (caution).
- Skin effects: Moderate or low toxicity (warning or caution).

Chronic toxicity to humans: Glyphosate may be associated with chronic health effects in certain test animals when controlled at high doses over prolonged periods. While it is unlikely that human users would be exposed to doses as high as those used in the trials, doses of glyphosate that exceed approximately 300 mg/kg (dose per body weight) may cause signs of toxicity, including decreased body weight gain, changes in certain biochemical parameters in blood as well as tissues, and inhibition of some enzymes involved in metabolism (SERA 2011). Glyphosate does not cause serious reproduction problems when fed to rats at moderate to high doses over two or three generations (WSDOT 2006a). Also, the EPA classifies glyphosate as a Group D human carcinogen (unclassifiable) because existing studies provided conflicting results (WSDOT 2006a).

Human risk assessment: EPA/OPP states that risks associated with glyphosate use to workers and the general public are minimal. WSDOT (2006a) reported that all HQs were less than 1 in scenarios of average exposure to workers and the general public. In the risk assessment

by the USDA Forestry Service, the highest HQ was only 0.1 when doing ground broadcast applications (SERA 2011). Cancer risk is less than 1 in 100,000, indicating negligible risk (WSDOT 2006a).

Wildlife effects: Glyphosate toxicity to mammals and birds is relatively low. The acute toxicity of glyphosate formulations to wildlife is summarized as follows.

- Mammals (oral/dermal LD50): Practically nontoxic.
- Birds (oral LD50): Practically nontoxic.
- Aquatic animals (oral LC50): Moderately toxic to practically nontoxic.

However, its broad spectrum of herbicidal activity may cause the destruction of habitats and food sources for some birds and amphibians, leading to population reductions (Carlisle 1988). Aquatic animals are more sensitive to glyphosate formulations. Their level of toxicity increases with higher water temperatures and pH. Glyphosate also adversely affects some soil invertebrates including springtails, mites, and isopods. Of nine herbicides tested for their toxicity to soil microorganisms, glyphosate was found to be the second most toxic to a range of bacteria, fungi, actinomycetes, and yeasts (Carlisle 1988). It is not expected that most endangered terrestrial or aquatic organisms will be affected by the correct uses of glyphosate. However, many endangered plants as well as the Houston toad (because glyphosate may destruct its habitat) may be at risk (EPA 1993). EPA is deferring any use modifications or labeling amendments until it has published the Endangered Species Protection Plan and has given registrants guidance regarding endangered species precautionary labeling.

Environmental effects: When glyphosate comes into contact with the soil, it can be rapidly bound to soil particles and be inactivated (EPA 1993). Because of its adsorption to soil, glyphosate is not easily leached and is unlikely to contaminate ground water.

Metsulfuron Methyl

Metsulfuron Methyl is used to control broad leaf weeds and some annual grasses. It kills plants by inhibiting cell division in shoots and roots. Metsulfuron Methyl is an active ingredient of Escort XP, which is approved by TxDOT.

Acute toxicity to humans: Metsulfuron methyl has low to very low toxicity when people eat, touch, or inhale it. It also has low toxicity for acute dermal exposure and primary eye

irritation and has the least toxicity for all other acute exposures. Its acute toxicity to humans is summarized as follows:

- Oral LD50: Very low toxicity (caution).
- Dermal LD50: Low toxicity (caution).
- Inhalation LC50: Very low toxicity (caution).
- Eye effects: Low toxicity (caution).
- Skin effects: Low toxicity (caution).

Chronic toxicity to humans: Studies on the chronic toxicity of metsulfuron methyl using various species suggested decreased body weight as the most consistently observed adverse effect (SERA 2004). Metsulfuron methyl did not cause reproduction problems or birth defects in tests of rats over two generations at moderate to high doses. The offspring had slightly lower growth rates. However, it caused offspring deaths in tests with rabbits at high doses. Two-year tests with rats showed no increase in the number of tumors (WSDOT 2006b).

Wildlife effects: No specific study on wildlife mammals was found, but it seems reasonable to assume the most sensitive effects in wildlife mammalian species will be the same as those in experimental mammals (i.e., decreased body weight gain). Studies on ducks indicate that birds are less sensitive than mammals to the toxic effects of metsulfuron methyl (EPA 1986). No significant impacts larger than the impact on experimental mammals were identified in studies on other species including honey bees, fish, and soil microorganisms (SERA 2004). The acute toxicity to wildlife is summarized as follows:

- Mammals (oral/dermal LD50): Practically nontoxic.
- Birds (oral LD50): Practically nontoxic.
- Aquatic animals (oral LC50): Practically nontoxic.

Environmental effects: The breakdown of metsulfuron methyl in soils is largely dependent on soil temperature, moisture content, and pH. The chemical degrades faster under acidic conditions and in soils with higher moisture content and higher temperature (Smith 1986). The chemical is stable to photolysis but will break down in ultraviolet light. Half-life estimates for metsulfuron methyl in soil are wide-ranging from 14 to 180 days, with an average of 30 days (Wauchope et al. 1992). Reported half-life values (in days) for soil are 178 for clay, 102 for sandy loam, 14–105 for clay loam, 120–180 for silty loam (Smith 1986; Wauchope et al. 1992). Metsulfuron methyl has a moderate to high mobility in the soil and is relatively persistent in the

environment, particularly when applied in the fall. These aspects would be of concern under most circumstances. However, metsulfuron methyl is applied at very low rates (3–4 oz/acre) and therefore the amounts which reach the soil are quite low. Thus, metsulfuron methyl should not affect groundwater by leaching or migrating from the applied area (MDAR 2011).

Human risk assessment: The highest hazard quotient for workers is 0.02 for directed ground spray. For all of the acute and chronic exposure scenarios on the general public, the hazard quotients are below the level of concern of 0.2 (SERA 2004).

Clopyralid

Clopyralid is a selective herbicide used for control of broadleaf weeds, especially thistles and clovers. It mimics a plant growth hormone and causes uncontrolled and disorganized plant growth that leads to plant death. Clopyralid is the sole active ingredient (40.9%) in the herbicide Transline, which is included in the TxDOT-approved herbicides list.

Acute toxicity to humans: Pure clopyralid is practically non-toxic to birds and mammals. The LD50 for rats is 4,300 mg/kg. For mallards and bobwhite quail, the LD50s are 1,465 mg/kg and >4,640 mg/kg, respectively. Pure clopyralid has low acute toxicity when people accidentally eat, touch, or inhale residues. Transline, a formulated product, also has low acute toxicity through skin contact, showing >5,000 mg/kg of LD50 for rabbits. A major hazardous effect from clopyralid products is eye irritation. Studies warn that some clopyralid-based commercial products (e.g., Curtail®, and Hornet®) may cause severe eye damage, including permanent impairment of vision, and even blindness (Dow AgroSciences 1998[e]-[f]), due to other ingredients. While the majority of clopyralid ingested by mammals is excreted unmetabolized in their urine within 24 hours (DowElanco 1997), some amounts can be retained in their livers and kidneys (Tu et al. 2001). The acute toxicity of pure clopyralid and Transline are summarized as follows:

- Oral LD50: Low toxicity (caution).
- Dermal LD50: Very low toxicity (caution).
- Inhalation LC50: Very low toxicity (caution).
- Eye effects: Low toxicity (caution).
- Skin effects: Very low toxicity (caution).

Several inactive ingredients in clopyralid products adversely affected tested animals. Cyclohexanone produced tearing and burning of the eyes, vomiting, diarrhea, and dizziness.

Triethylamine caused a severe eye irritation and chemical pneumonia. Polyethoxylated tallow amines cause eye burns, nausea, and are acutely toxic to fish (Cox 1998). Some clopyralid products include 2, 4-dichlorophenoxyacetic acid which is known as a carcinogen though it is still controversial (Ibrahim et al. 1991).

Chronic toxicity to humans: Prolonged exposure to clopyralid products also may cause skin irritation (Dow AgroSciences 1998[a]-[e]). Subchronic and chronic studies on laboratory animals exposed to clopyralid have reported some harmful effects including liver weight gain, a decreased number of red blood cells, urinary tract problems, some changes in stomach tissue, and decreased body weight at the moderate to highest dose (WSDOT 2006; EPA 1997[a]). Clopyralid also may cause substantial reproductive problems. In a test with rabbits, clopyralid resulted in:

- Reduced fetal weight.
- Increased skeletal abnormalities in fetuses.
- An increased number of fetuses that have hydrocephaly, an accumulation of excess fluid around the brain (EPA 1997[a]).

Wildlife effects: Prolonged exposure to clopyralid can adversely affect safflower and peas 220 days after treatment (Tanphiphat 1987). The potato is one of the most susceptible crop plants to this chemical. Only 0.07 percent of typical agricultural rates can damage this plant (EPA 1990[a)]). Of the 11 species of endangered plants that EPA recognized as potentially susceptible to clopyralid (Cox 1998), five are cactus species. Uses of clopyralid attempting to discourage undesirable species and promote natives have yielded mixed results. Undesirable broadleaf plants were successfully discouraged, and native grasses were slightly promoted by applying clopyralid. However, the application also eliminated native broadleaf species and encouraged undesirable grasses (Tyser et al. 1998; Pywell et al. 1996). The acute toxicity to wildlife can be summarized as follows:

- Mammals (oral/dermal LD50): Practically nontoxic.
- Birds (oral LD50): Practically nontoxic.
- Aquatic animals (oral LC50): Practically nontoxic.

Environmental effects: Clopyralid tends to be persistent in soil, water, and vegetation. Although soil microbes degrade this substance almost entirely, it is resistant to photo or chemical degradation. The half-life of clopyralid in soils ranges from 14 to 56 days (WSDOT 2006), but it

may persist from one week to one year depending on the soil type, temperature, and application rate (Pik et al. 1977; Smith and Aubin 1989; Bergstrom et al. 1991; Bovey and Richardson 1991; DowElanco 1997 therein Tu et al. 2001). Clopyralid is not only mobile in soils but also very soluble in water. Due to these characteristics, clopyralid has "the potential to leach to ground water and contaminate surface water" (EPA 1997[b]). Despite its relatively low level of use, clopyralid was found in two of the 20 river basins that the U.S. Geological Survey studied (Cox 1998). However, field studies demonstrated that clopyralid has minimal potential to contaminate groundwater through leaching (WSDOT 2006), probably because clopyralid degrades more as as it passes through deeper soils. Clopyralid is very stable in compost and can be present in levels that will harm plants.

Human risk assessment: WSDOT evaluated several human exposure scenarios, including workers who prepare, load, and apply the herbicide, and members of the public who may be exposed when they walk, hike, or jog in sprayed vegetation, or who pick or eat drift-contaminated berries or vegetables. The HQs of all the scenarios are less than one, which means negligible risks to workers and general public (WSDOT 2006).

COST-BENEFIT PERFORMANCE OF GENERIC HERBICIDES

A major advantage of generic products is their cheaper price. For example, Ward (2010) suggested that a use of generic herbicides can save $1.22 per acre (5 percent cost savings) for corn and $2.11 per acre (10 percent savings) for soybean compared to brand-name products. This price gap is possible because generic manufacturers did not pay the costs of herbicide development and mass advertisement.

One of the main interests is whether generic herbicides perform as well as brand-name ones with the lower costs. In essence, generic and brand-name herbicides should have the same performance because both have the same active ingredients. It is important to note that while the percentage of active ingredients may the same, the quality of the active ingredients may be different. While the active ingredients in generic and branded herbicides are required to be equal, the inactive ingredients are not required to be equal. For soil-applied herbicides, inactive ingredients would only affect handling and mixing properties of the formulation, and therefore their performances would not be changed. On the contrary, inactive ingredients of leaf or stem-applied products can have a more significant influence on performance. For example, an addition

of surfactant improves performance by helping the products stick better to leaf surfaces. "Inactive ingredients are classified into two categories: activator adjuvants and modifier adjuvants. Activator additives increase the post-emergence activity of herbicides, usually by increasing herbicide movement into the leaf tissue. They include oils, surfactants, and fertilizers. Modifier additives alter the application characteristics of the spray solution and include anti-foaming agents, compatibility agents, and drift control agent" (Bernards 2010).

When choosing a generic herbicide product that has an equivalent performance with matching brand-name products, the user should also consider the physical form of the active ingredient. Products may differ in the chemical form even if the active ingredient is same. For example, Roundup Pro® and Roundup PROMAX are representative glyphosate-based brand-name products. While the former is isopropylamine salt formulation, the latter is potassium salt formulation. According to Monsanto's product description, the smaller molecule of potassium salt formulation allows concentration of more active ingredients and reduces dosage for the same level of performance.

When all these conditions are controlled the same way, generic products perform similar to matching brand-name products with lower costs. Many experimental studies support this fact, including:

- Reclaim® vs. Clopyralid 3 and Remedy® vs. Triclopyr 4EC when applied as either a leaf spray or stem spray for the control of mesquite (Cadenhead et al. 2007).
- Roundup UltraMax® compared to Touchdown IQ (Hartzler 2001).
- Glyphos Gold, Glyphomax Plus and other generic glyphosate products (Hartzler 2001).
- Another glyphosate study of Roundup Ultra® Dry vs. Clearout41 Plus (Kappler et al. 2005).
- Desmedipham and phenmedipham products of Betamix® vs. AgValue for the control of sugar beet (Dexter et al. 2002).
- Picloram products of Tordon 22K® vs. Micro Flo for the control of prickly pear and small cedar on Texas rangelands (McGinty 2003).

Not all generic herbicides perform as well as brand-name products. In fact, very few do. Just because they have the same active ingredient does not mean they perform the same. Inert

(inactive) ingredients affect how well soil-applied herbicides perform. They may affect soil mobility and degradation.

Currently, TxDOT does not use generic herbicides and is required to accept the lowest price in the bid process. Compatibility problems have already arisen with some to these low bid materials resulting in considerable down time cleaning and repairing equipment. Some of these generic products have caused pump failure due to inactive ingredients.

GENERIC HERBICIDE USE BY OTHER STATES

Oklahoma Vegetation Management Program

The Oklahoma Department of Transportation (ODOT) has a solid roadside vegetation management guideline, which encompasses mowing, herbicide, and biological weed control (ODOT 2010). The majority of the guideline is associated with herbicide use. A unique characteristic of this program is that it allows the uses of generic herbicides once they meet minimum standards for efficacy and compatibility.

ODOT's Approved Herbicide and Adjuvant List (AHAL) Program provides a list of herbicides and adjuvants that have met the minimum standards and how they determine the performance of product. The minimum performance criteria can be summarized as follows:

- All herbicides must maintain current registrations with the EPA and Oklahoma Department of Agriculture, Food& Forestry (ODAFF).
- Herbicides with an active ingredient not on the current ODOT AHAL will require a sample product submission to the Oklahoma State University Roadside Vegetation Management (OSU RVM) Research Program to conduct efficacy and compatibility testing.
- Efficacy data must include a minimum of 15, 30, and 60 days-after-application evaluations on roadside weed control and bermudagrass injury as compared to current ODOT standard treatment(s).
- Efficacy data submitted from another Land Grant University Research Program that does not include compatibility data will require compatibility testing.
- All adjuvants require a minimum of compatibility testing with current standard ODOT broadcast herbicide treatments. A minimum of 1 pint (liquid adjuvant) or 1 lb (dry adjuvant) must be submitted for testing purposes.

- Tank mix compatibility testing should be conducted using a standard jar test method.
- The following types of adjuvants are currently exempt: non-ionic surfactants, non-ionic surfactants (aquatic approved), sprayable grade ammonium sulfate, water soluble dyes, oil soluble dyes, and activated charcoal clean-up products.

The 2009 ODOT list includes 24 brand-name as well as 16 generic herbicide products. All 16 adjunct products are generic (Appendix A).

ODOT has conducted annual surveys from eight local divisions to record herbicide use trends, successes, failures, and challenges. According to surveys in 2004 and 2009, almost all projects used brand-name products (e.g., Roundup Pro, Campaign®, Honcho®) although 40 percent of the ODOT herbicide lists are generic. Some generic products were preferred for small projects such as bush control and aquatic weed control. A generic glyphosate product (i.e., Mirage) was often used for large projects in 2004, but it was not found in 2009.

Washington Integrated Roadside Vegetation Management Plan

Washington Department of Transportation (WSDOT) is also one of few state transportation agencies allowing the use of generic herbicides. WSDOT has conducted independent assessments on herbicide risks, based on toxicity and environmental fate. Findings from these assessments have been used to establish an approved list of herbicides for their Integrated Roadside Vegetation Management (IVM) plan. The list includes three generic products among eight glyphosate products and two generic herbicides among four metsulfuron methyl products. No generic clopyralid product is included in the list.

CHAPTER 3:
ONLINE SURVEY OF SELECTED HERBICIDE PROFESSIONALS

METHODOLOGY

An online survey of practice was developed and administered to various herbicide professionals to determine the following:

- Which agencies allow the use of generic herbicides on their rights-of-way?
- How have the generic herbicides performed relative to their name brand counterparts?
- What problems have they encountered in the use of generic herbicides (efficacy, supply, availability, customer support, etc.)?
- Are there any agency recommendations for the use of generic herbicides?
- Does the agency have research data or results regarding the use of generic vs. branded herbicides?

The survey was designed to optimize responses by balancing the length and the level of detail of the survey with the respondent willingness to complete the survey with useful information. The survey instrument was formatted as an on-line survey using a web-based survey administration facilitator. The project director (PD) reviewed a draft survey, and a final survey instrument was developed based on the draft survey as well as the comments provided. Appendix B presents the survey form.

As the federal government mandated, the Texas A&M University's Institutional Review Board (IRB) for Human Subject Protocols must approve all research projects involving human subjects that the University conducted. This survey was done upon IRB approval of the study and survey instrument.

RESULTS

The survey respondents included herbicide applicators, inspectors, instructors and those involved with product approval. Of respondents, 62 percent answered their agency have used or currently using generic herbicides.

Of the respondents that indicated that their agencies no longer use generic herbicides, the top two reasons were that the performance of generic herbicides was found not equivalent to

branded herbicides and that the generic herbicides lacked the customer support available with branded herbicides. Other responses included no long term cost savings was found with generic herbicide use. The lack of generic product availability was also mentioned (Figure 1).

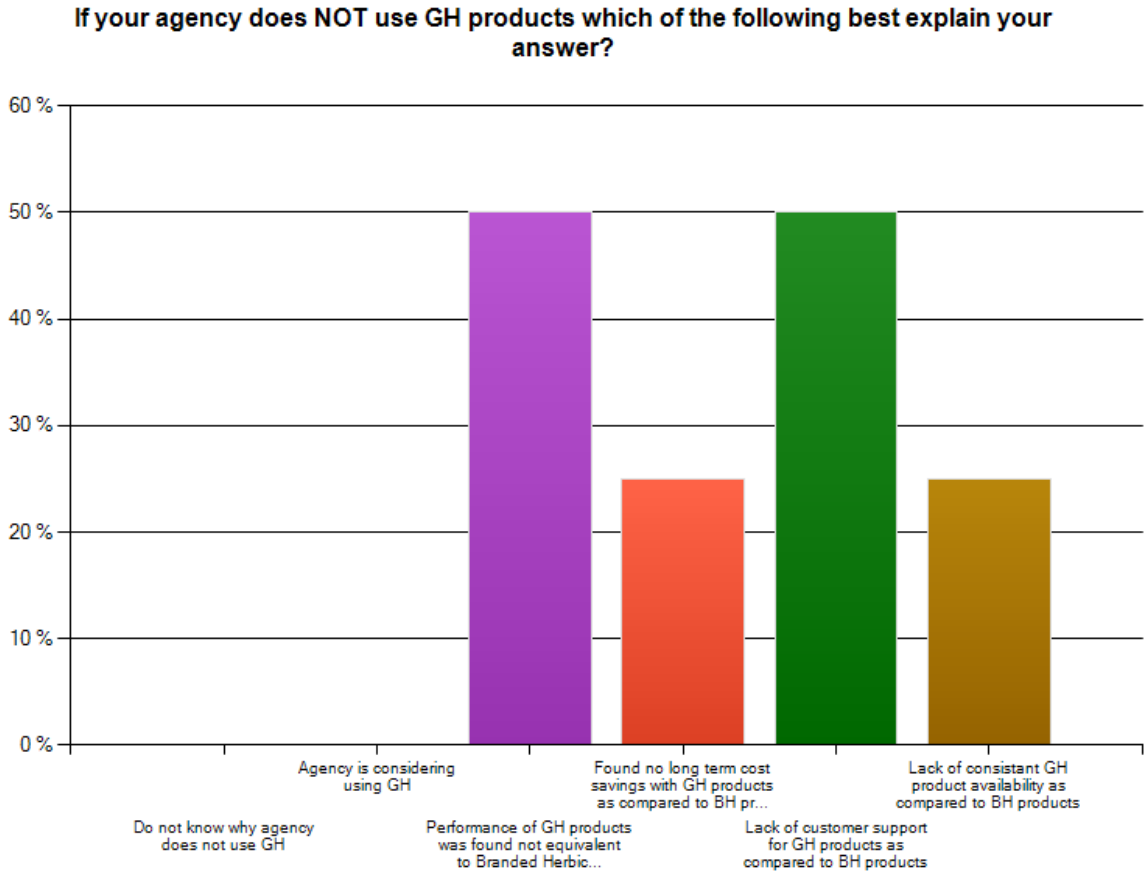

Figure 1. Survey Results on the Reason that Generic Products Are Not Used.

Respondents indicated that the safety of generic herbicides for applicators and general public rated either "good" or "excellent" (Figure 2). Most surveyees responded that the generic products did not require different preparation or application equipment.

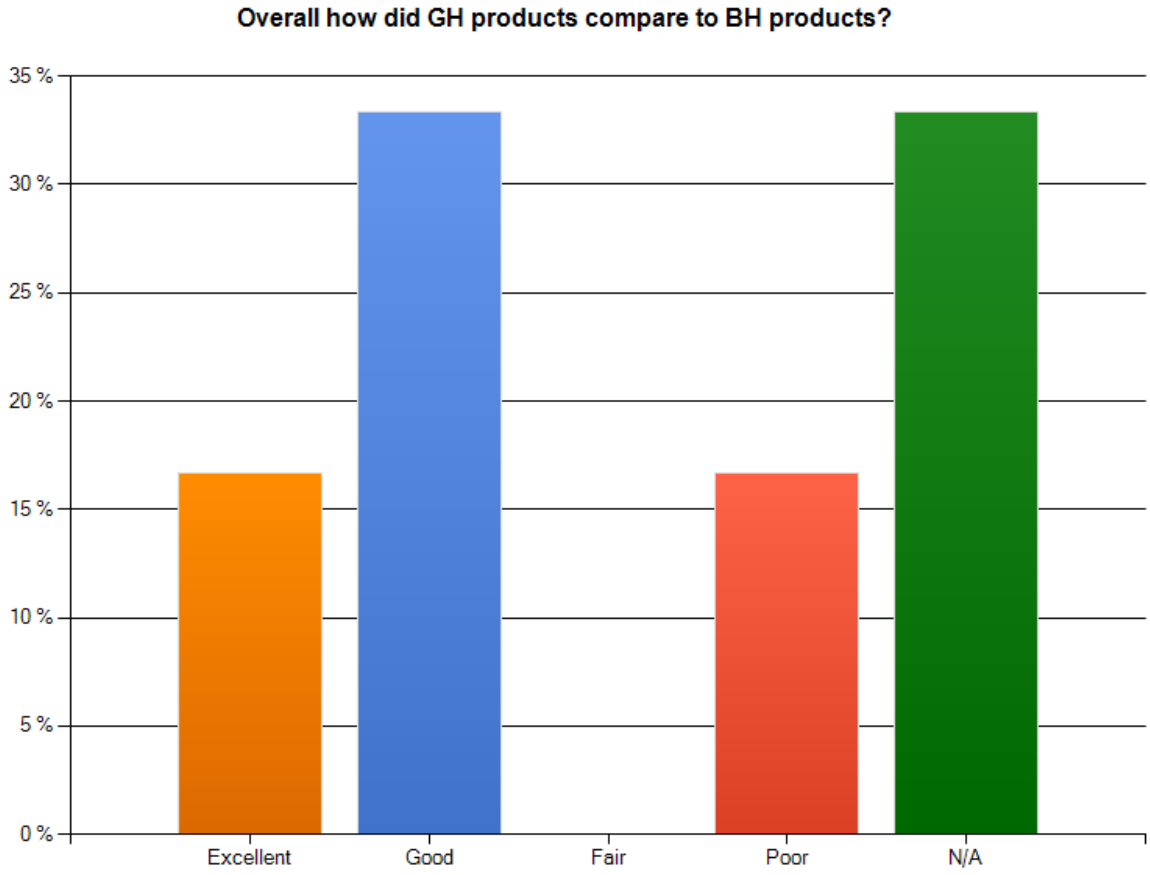

Figure 2. Survey Results on the Performance of Generic Herbicides.

Survey results on other questions (e.g., surfactant use, seed company warranty issue, etc.) are presented in Appendix C.

CHAPTER 4:
EFFECTIVENESS OF GENERIC AND BRANDED HERBICIDES

METHODOLOGY

To evaluate the effectiveness of generic and branded herbicides, field tests were conducted on roadside sections of highway FM-50 in Bryan, TX. Each roadside section had a 0.9-mile grass field and was divided into nine 0.1-mile test plots. The research team treated eight plots with different combinations of herbicides and left one site untreated as the control. The FM-50 site was designed to evaluate glyphosate products. Six generic products were tested in each of six plots, and Roundup PROMAX was treated in two plots. Table 4 presents detailed herbicide application specifications. Figure 3 shows the study site.

Figure 3. Test Site on Highway FM-50, Bryan, TX.

Table 4. Herbicide Application Specifications for the FM-50 Site.

Trt No	Product Name	Form Conc	Form Type	Product Rate (oz/ac)	Grow Stg	Appl Code
1	Wise-Up Plus*	4	SL	8	NCPOPE	A
	Outrider	75	WP	1.33	NCPOPE	A
	Escort XP	60	WP	1	NCPOPE	A
2	Helosate Plus*	4	SL	8	NCPOPE	A
	Outrider	75	WP	1.33	NCPOPE	A
	Escort XP	60	WP	1	NCPOPE	A
3	Killzall*	4	SL	8	NCPOPE	A
	Outrider	75	WP	1.33	NCPOPE	A
	Escort XP	60	WP	1	NCPOPE	A
4	Compare & Save*	4	SL	8	NCPOPE	A
	Outrider	75	WP	1.33	NCPOPE	A
	Escort XP	60	WP	1	NCPOPE	A
5	Makaze*	4	SL	8	NCPOPE	A
	Outrider	75	WP	1.33	NCPOPE	A
	Escort XP	60	WP	1	NCPOPE	A
6	Eraser*	4	SL	8	NCPOPE	A
	Outrider	75	WP	1.33	NCPOPE	A
	Escort XP	60	WP	1	NCPOPE	A
7	Roundup PROMAX	4.5	SL	6	NCPOPE	A
	Outrider	75	WP	1.33	NCPOPE	A
	Escort XP	60	WP	1	NCPOPE	A
8	Roundup PROMAX	4.5	SL	8	NCPOPE	A
	Outrider	75	WP	1.33	NCPOPE	A
	Escort XP	60	WP	1	NCPOPE	A
9	Untreated					

*generic products

RESULTS

All test plots effectively controlled the target species Johnsongrass although the rate of kill was variable. For TxDOT use, the rate of kill is not an important issue as long as the efficacy is achieved. Each group of test plots was installed on the same day. Differences in efficacy may have been noticed if environmental factors (temperature, moisture, solar radiation, etc.) had not been equal.

CHAPTER 5:
COST ANALYSIS

METHODOLOGY

Comparing costs of generic pesticide products to brand-name materials is not as straightforward a comparison as one might initially think. The generic product may have a cheaper price but may not be loaded with the same amount of active ingredient as the brand-name product. Therefore, to achieve an equivalent rate of active ingredient, more of the generic material may need to be used, thereby potentially eliminating whatever cost savings was realized at the initial purchase of the generic product.

If an active ingredient is intended as a post-emergence material, it would most likely need to be accompanied by a surfactant to enhance the absorption of the active ingredient into the plant. The brand-name product may include this surfactant and the generic may not. Also, the generic may not contain the same surfactant if it is being included and may have slightly different efficacy. Therefore, the surfactant would have to be purchased and used in order for an equivalent effectiveness of the generic to be realized thus eliminating any cost savings.

To compare costs of generic herbicide products to brand-name products properly, the research team identified generic products with the same or similar specification (e.g., ingredients, bottle size, active ingredient weight, and formulation) as matching brand-name products (see product labels in Appendix D). The 2011-12 TxDOT contract prices were used for branded product prices, while the prices of generic products were collected from online stores. Only the lowest product prices were considered in this analysis, respecting the wide variance in prices among stores. Other transaction costs (e.g., tax, shipping, and fees) were excluded in the price information.

Eight brand-name products approved by TxDOT and five matching generic products were surveyed. The research team could not find generic product information equivalent to four brand-name products (i.e., Milestone® VM+, Vista XRT®, Landmark XP®, and Outrider®).

RESULTS

Comparison of Unit Product Prices

Table 5 compares unit prices of surveyed generic and branded products. Since the amount of acid equivalent (or active ingredient) was most critical in determining product performance and application rate, the unit price was calculated as the product price per total acid equivalent (or active ingredient) weight. This approach was useful particularly for Roundup PROMAX, for which we could not find any generic product with the same formulation. Roundup PROMAX has a different formulation with compared generic products (i.e., potassium salt versus isopropylamine salt). Acid equivalent means the proportion of a formulation that can be converted to the original patent acid. With its more concentrated formulation, one gallon of Roundup PROMAX contains the glyphosate acid equivalent of 6 quarts of generic products (1.5 times). It should be noted that, in this case, a unit price calculation based on active ingredient weight overestimates the cost saving by a use of generic products. Calculations using active ingredient weight estimate that the use of the cheapest generic products, Glyphosate 4+, can save 18.3 percent of product cost. Roundup PROMAX and Glyphosate 4+ have 88 and 64 ounces per gallon of active ingredient, respectively. The unit price per active ingredient weight is $0.33 per ounce for the brand product (= $96.52/ 3.34 gal / 88 oz) and $0.27 per ounce for the generic one (= $42.95 / 2.5 gal / 64 oz). However, based on these calculations, the use of this generic product can actually save 10.8 percent, which is greater than the cost saving mistakenly estimated by active ingredient weight. The acid equivalent of Roundup PROMAX (potassium salt) and generic products (isopropylamine salt) is 81.5 percent and 75 percent, respectively. The unit price per acid equivalent is $0.40 per ounce for Roundup PROMAX (= $96.52 / 294 fl.oz. / 0.815) and $0.36 per ounce for Glyphosate 4+ (= $42.95 / 160 fl.oz. / 0.75).

The differences in unit price between branded and generic herbicides varied by active ingredient. For glyphosate herbicides, the unit prices of generic products were greatly wide, from 10.8 percent cheaper to 45.2 percent more expensive than the branded product. This would be due to the variety in the business sizes of online stores.

Surprisingly, the research team could not find any generic clopyralid product and metsulfuron methyl product cheaper than branded products. Unit prices of generic products were 14.9 percent and 30.7 percent higher than Transline and Escort XP, respectively. This unexpected finding must be because we compared government contract prices to online store

prices. For example, TxDOT can purchase branded herbicides at lower prices than regular prices. Distributors can provide them at the lower prices because they can make profit through incentive packages that branded manufacturers offer for large volume purchases. Meanwhile, online prices of some generic glyphosate products were lower than the TxDOT contract price of Roundup PROMAX. One reason for the price variance by active ingredient would be their different supply levels. For example, glyphosate products were available in more distributors than other active ingredient products. The more supply could result in the lower price.

Inert ingredient also influences product price. Pathfinder II® is relatively expensive among triclopyr products because it uses naturally-derived, nonpetroleum oil as inert ingredient. The inert gradients of other Triclopyr products are not revealed. The use of environmentally-friendly ingredient lowers active ingredient concentration rate and increases product cost.

Table 5. Product Prices of Brand-Name Herbicides and Generic Herbicides.

Active Ingredient(s) Common Name	Product Name	Manufacturer/ Distributor	Size	Price ($)	A.E. (or A.I.) Weight (oz)	Unit Price per A.E. or A.I. ($/oz)	Difference in Unit Price per A.E.
Clopyralid	Transline*	Dow Agro.	2.5 gal	348.20	120	2.90	
	Clopyralid	Alligare	2.5 gal	399.99	120	3.33	+14.9%
Glyphosate	Roundup PROMAX*	Monsanto	3.34 gal	96.52	240.5	0.40	
	41% Glyphosate	Comp.-N-Save	2.5 gal	45.97	120	0.38	−4.6%
	Glyphosate 4+	Alligare	2.5 gal	42.95	120	0.36	−10.8%
	Eraser	Surrender	2.5 gal	69.95	120	0.58	+45.2%
Metsulfuron methyl	Escort XP*	Dupont	4 lbs	244.76	(38.4)	6.37	
	MSM 60 DF	Alligare	1 lbs	79.99	(9.6)	8.33	+30.7%
Triclopyr	Pathfinder II*	Dow Agro.	2.5 gal	70.88	30	2.36	
	N/A	.					
Aminopyralid	Milestone VM+*	Dow Agro.	5 gal	153.75	8	0.96	
	N/A						
Fluroxypyr	Vista XRT*	Dow Agro.	5 gal	682.18	224	3.05	
	N/A						
Sulfometuron/ chlorsulfuron	Landmark XP*	Dupont	4 lbs	424.90	(48)	8.85	
	N/A						
Sulfosulfuron	Outrider*	Monsanto	1.25 lbs	239.39	(15)	15.92	
	N/A						

*TxDOT approved products

NOTE 1: A.E. (acid equivalent); A.I. (active ingredient)

NOTE 2: Price difference was calculated by [(generic product price – branded product price) / branded product price]

The prices of generic products might be even larger when considering costs for additives and application. Regarding surfactant use, both generic and branded glyphosate products have different specifications. Although both branded and generic products already include the unknown amount of surfactant, generic glyphosate products allow an additional use of surfactant, differently with the branded product. Generic products recommended 2 quarts of surfactant per 100 gallons of spray solution when using surfactants with a minimum of 70 percent of active ingredient. A 1 percent glyphosate spray solution of 100 gallons includes 1 gallon of the herbicide. Because the selected generic glyphosate products include 4 lb per 1 gallon of active ingredient, the amount of surfactant needed for 1 ounce of active ingredient is 1 fluid ounce (2 qt / 4 lb = 64 fl oz / 64 oz). The unit price of surfactant is $0.06 per fluid ounce, which is 18 percent of the branded product price ($0.33 per ounce). In addition, the mixing of surfactant requires extra labors. The different concentration rate between the branded and generic products also affects application cost. Roundup PROMAX includes 4.5 pounds of acid equivalent per gallon, while generic products include 3 pounds per gallon. Generic products need 50 percent more spray to apply the equivalent amount of acid to the branded one. Application cost will rise as project size increases.

Product Purchasing Cost by Project Type

The research team also calculated money savings made by using generic products; for example, for herbicide application projects (Table 6). The Herbicide Operation Manual (TxDOT 2012) was followed for application rate. Operational costs were assumed the same between brand name and generic products as the researchers checked that their specifications and application guidelines were equivalent.

Cost savings by using generic products varied from $2.88 saving to $3.54 increase per acre, depending on the project type. Projects that require glyphosate herbicide (such as the application on the edge of pavement, itchgrass, etc.) would generate more savings from using generic products. Projects using a large amount of clopyralid or metsulfuron methyl herbicide (such as African rue, kudzu, etc.) may not help save costs from using generic products.

Table 6. Costs of Example Herbicide Application Projects (Based on Surveyed Product Prices).

Target/Type of Control Desired	Herbicide and Application Rate per Acre (Recommended by TxDOT)	Product Cost (US$/ac)		Saving (US$/ac)
		Brand Name	Generic	
Guardrails, delineators, mailboxes, signage (removal of tall weeds); Johnson grass	Roundup PROMAX (8 oz) + Escort XP (1 oz) + Outrider (1.33 oz)	21.58	22.52	+0.94
Edge of pavement (bare ground)	Roundup PROMAX (3 qt) + Landmark XP (2~3 oz)	35.36~42.00	32.48~39.12	-2.88
Guinea grass; Wildoats or jointed goatgrass	Roundup PROMAX (10 oz)	2.30	1.99	-0.31
Itchgrass	Roundup PROMAX (12 oz) + Landmark XP (2 oz)	16.04	15.68	-0.36
Sunflower; Musk Thistle	Transline (10 oz)	10.90	12.50	+1.60
Field Bindweed; Common sunflower; Western Bitterweed; Turnip weed; Morning glory vine; Other broadleaf weeds	Escort XP (1 oz)	3.82	5.00	+1.18
African rue	Escort XP (3 oz)	11.46	15.00	+3.54
Kudzu	Transline (21 oz) + surfactant (2 qt/gal)	22.89 + surfactant	26.25 + surfactant	+3.36

NOTE: Costs were calculated using product cost only. Operational costs were assumed the same between branded and generic products as their specifications and application guidelines were equivalent.

Other Considerations

Actual cost savings would be different with the analysis result, depending on the performance and properties of product ingredients. Lower-performing products might require more frequent applications in a given period and increase cost. Not every same chemical has the same quality. The formulation of a generic product's active ingredient may differ from that of the brand name. Generic manufacturers may use different technologies to produce active ingredients. In addition, inactive ingredients are not disclosed in both brand name and generic products even if they are account for 20 percent to 80 percent of product weight. A generic product does not have to include the same inactive ingredient as brand-name products. Inactive ingredients may

influence performance and applicability of the product. Herbicide applications frequently involve mixing with other herbicides and additives. A certain kind of chemistry among the mixed chemicals may affect the performance and applicability.

A major concern to TxDOT would be if a generic product is accepted on a bid at a lower price than its brand name competitor, the distributor of the generic is going to have trouble meeting their contractual commitment over the life of the contract for two reasons. First, generic product prices fluctuate greatly during the application season (spring/summer). This is because of the availability of the imported technical materials. In the fiscal year 2011, the amount of Roundup PROMAX (48.7% of active ingredient) used by TxDOT reached 57,191 gallons (Table 7), which is equivalent to 34,315 bottles of 2.5-gallon 41% active ingredient generic products when considering acid equivalent. It is uncertain if generic herbicide providers can meet the amount required for TxDOT projects. When availability of generic products decreases, their price becomes very similar to the branded product price. Also, when generic products are not available in the middle of a project, distributors may with go the branded product manufacturers to meet their needs. However, this option is not always available because branded product manufacturers have commitments to their distributors.

Table 7. Herbicide Amount Purchased by TxDOT.

Product Name (Active Ingredient)	FY2012	FY2011
Roundup PROMAX (glyphosate)	57,191 gallons	59,866 gallons
Transline (clopyralid)	3,703 gallons	2,405 gallons
Escort XP (metsulfuron methyl)	7,800 pounds	7,812 pounds

CHAPTER 6:
CONCLUSIONS AND RECOMMENDATIONS

TxDOT currently uses three herbicides (Roundup PROMAX , Escort XP, Transline) in its vegetation management program that have generic competitors. The decision to include generic herbicides in the TxDOT vegetation management plan requires many more considerations than simply up-front purchase price. Performance, toxicology, and environmental/worker safety must be considered to ensure a safe, effective program.

PERFORMANCE

In general, generic herbicides often perform as well as branded herbicides. Generic herbicides are required to have the same active ingredients as branded herbicides. While the *percentage* of active ingredients must be the same in both types of herbicides to achieve the equivalent performance, oftentimes there is a difference in the *quality* of the active ingredient. For example, the labels of most glyphosate products report the active ingredient as well as the acid equivalent. When calculating the quantity of the active ingredient in a glyphosate product, the weight of both the acid and salt in the product are considered. A better way to determine the performance of a product is to compare acid equivalent rates rather than active ingredients since different salt are use in similar products.

The inactive ingredients of herbicide products include solvents, stabilizers, emulsifiers, surfactants, and other additives. These additives can make a difference in the performance of the product and are usually grouped together in the labels as inert ingredients with no additional information revealed to the buyer.

ENVIRONMENTAL/WORKER SAFETY

Allowing the use of generic herbicides could potentially result in a dramatic increase in the number of herbicides that TxDOT used, each with its unique application rates/procedures. Multiple application rates/applications could cause confusion and lead to possible misuse of the product among the hundreds of TxDOT statewide applicators.

Branded manufacturers have technical and environmental groups that can assist end-users with complaints, spills, exposure, and compatibility problems. These groups do not exist in the smaller generic companies.

REDUCED COST

Many factors need to be considered to determine if there is a cost savings by using generic herbicides. Product availability, amount of herbicide purchased, product formulation often affect the price. As indicated in Tables 5 and 6 TxDOT is able to purchase branded herbicides at a rate which is often lower than generic prices thus eliminating any lower initial purchase price. Generic herbicides may not maintain the lower price throughout the life (5 years) of a state pesticide contract because of extreme price fluctuations and product availability. While branded manufacturers have guaranteed the price and availability of an herbicide over the life of a contract, branded manufacturers will not do so.

Product availability is an important consideration due to TxDOT large herbicide need. Many of the generic herbicides are produced overseas. For instance, China is one of the leading manufacturers of glyphosate. Since 2011, a stagnant demand and high cost of raw materials and utilities have resulted in the depressed manufacture of glyphosate in China and therefore in smaller quantities available. On the other hand, Monsanto manufactures glyphosate in two U.S. factories and has not experienced the same depressed results as some overseas companies.

Herbicide formulation will be a key factor in determining whether or not generic herbicides should be used. For example, pre-emergent herbicides are typically formulated as granules or a liquid. These two formulations require different application equipment. Pellets, wettable powders, and liquid formulations all require different application equipment. If herbicide formulations change, additional application equipment may be required.

OTHER CONSIDERATIONS

Manufacturer support after the sale is an important factor to consider. Many generic herbicides may not be backed by the manufacturer like their branded counterparts. This customer support offered by large brand name companies has benefitted TxDOT's relationship with the general public many times when a problem is encountered on the roadside.

Care should also be taken to determine if seed companies will warranty their products when generic herbicides are used. While it is generally true for crop production rather than roadside vegetation, many herbicide tolerant crops almost always require the use of branded chemicals. Problems caused by using an "off-label" generic may not be covered by chemical/seed company warranty.

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APPENDIX A:
ODOT APPROVED HERBICIDE AND ADJUVANT LIST

Herbicide Active Ingredient Common Names, Product Names, and Manufacturers on the 2009 ODOT Approved Herbicide and Adjuvant List

Active Ingredients Common Name	Product Name	Manufacturer
Aminopyralid	Milestone VM	Dow AgroSciences
Clopyralid	Transline	Dow AgroSciences
Dicamba	Banvel*	Microflo
Dicamba/diflufenzopyr	Overdrive	BASF
Diglycolamine salt of dicamba	Vanquish*	Syngenta
Diuron	Diuron 80 WDG*	Loveland Industries
Fluroxypyr	Vista	Dow AgroSciences
Fosamine	Krenite S	Dupont
Glyphosate	Honcho	Monsanto
	Honcho Plus	Monsanto
	Ranger Pro	Monsanto
	Roundup Pro Concentrate	Monsanto
	Mirage*	UAP-Loveland Products
	Mirage Plus*	UAP-Loveland Products
Glyphosate (aquatic)	AquaStar*	Albaugh
	AquaMaster	Monsanto
Glyphosate/2,4-D	Landmaster BW*	Albaugh
	Campaign	Monsanto
Imazapic	Plateau	BASF
	Arsenal	BASF
	Imazapyr 2 SL*	Veg. Mgmt., LLC
Imazapyr (aquatic)	Habitat	BASF
Imazapyr/diuron	Sahara	BASF
Metsulfuron methyl	Escort XP	Dupont
	MSM E-Pro*	Etigra
	Metsulfuron methyl*	Veg. Mgmt., LLC
MSMA	Weed-Hoe 108*	Albaugh
	MSMA 6.0 Plus*	Drexel
	Target 6 Plus*	Luxemburg Panol
Picloram	Tordon K	Dow AgroSciences
Sulfometuron	Oust XP	Dupont
	SFM E-Pro*	Etigra
	SFM 75*	Veg. Mgmt., LLC
Sulfometuron/metsulfuron	Oust Extra	Dupont
Sulfosulfuron	Outrider	Monsanto
Triclopyr amine	Garlon 3A	Dow AgroSciences
	Triclopyr 3A*	Microflo
Triclopyr ester	Garlon 4	Dow AgroSciences
	Garlon 4 Ultra	Dow AgroSciences
	Pathfinder II (RTU)	Dow AgroSciences

*generic products

APPENDIX B:
ONLINE SURVEY FORM

Texas Transportation Institute (TTI) is currently conducting research for the Texas Department of Transportation (TxDOT) to develop guidelines for the possible use of generic herbicides as a substitute for branded herbicides on the TxDOT rights-of-way. As a part of this research, TTI is gathering information from various transportation agencies and private companies to determine their use of generic herbicides. The purpose of this survey is to compile information on the effectiveness, cost, and safety as related to the use of using generic herbicides on public rights-of-way.

If you are not the right person in your agency's district/division to discuss the use of herbicides, kindly forward the link to this survey to the appropriate person(s) or e-mail Jett McFalls at herbicidesurvey@ttimail.tamu.edu with the contact information of the person(s) knowledgeable in your agency's use of herbicides. This survey should take approximately 15 minutes or less to complete.

This is a very important project for TxDOT. Your cooperation in completing this short survey is appreciated and necessary to collecting the data needed to ensure accurate results. Please complete the survey by June 15, 2012. Thank you for your assistance!

For more information regarding this project, please contact:
Mr. Jett McFalls – Project Supervisor
Texas Transportation Institute

Texas A&M University
TAMU 3135
College Station, Tx 77843-3135
Phone: 979-847-8709
E-mail: herbicidesurvey@ttimail.tamu.edu

*1. Name

Name:

Company:

Address:

Address 2:

City/Town:

State:

ZIP:

Country:

Email Address:

Phone Number:

2. How are you involved with your agency's herbicide program? Check all that apply.

- [ ] Product approval
- [ ] Training
- [ ] Applicator
- [ ] Inspector
- [ ] Other (please specify)

3. May we contact you for a follow-up email and/or telephone interview?

- ◯ Yes
- ◯ No

4. Has your agency ever used or currently using GENERIC HERBICIDE (GH) products?

- [ ] Yes
- [ ] No
- [ ] I don't know

5. If your agency does NOT use GH products which of the following best explain your answer?

- [ ] Do not know why agency does not use GH
- [ ] Agency is considering using GH
- [ ] Performance of GH products was found not equivalent to Branded Herbicide (BH) products
- [ ] Found no long term cost savings with GH products as compared to BH products
- [ ] Lack of customer support for GH products as compared to BH products
- [ ] Lack of consistant GH product availability as compared to BH products

Other (please specify)

6. Please list the GH products your agency has used.

7. If you answered NO on question #4 this concludes the survey. If you answered YES or I DON'T KNOW please continue. Before you exit please use the space below if you have any further comments.

8. Is the reason your agency does NOT use GH products based on any of the following?

- [ ] Agency experience
- [ ] Agency research or performance data
- [ ] GH product perception

Other (please specify)

9. Based on your experience please rate GENERIC HERBICIDE products compared to BRANDED HERBICIDE (BH) products.

	Generic Herbicide
Product PERFORMANCE (how well did the product meet your agency's expectations for vegetation control?)	
Product performance CONSISTENCY	
Product AVAILABILITY	
Product CUSTOMER SUPPORT	
Product SAFETY for APPLICATORS	
Product SAFETY for GENERAL PUBLIC	

10. Based on your experience please rate GENERIC HERBICIDE products compared to BRANDED HERBICIDE (BH) products.

	Generic Herbicide
Product COST PER ACRE as compared to BH products	
Product APPLICATION RATES as compared to BH products	

11. Overall how did GH products compare to BH products?

- ☐ Excellent
- ☐ Good
- ☐ Fair
- ☐ Poor
- ☐ N/A

12. Did the use of GH products require different preparation or application EQUIPMENT than the BH products?

- ◯ Yes
- ◯ No

If yes, please explain

13. Did the use of GH products require any additional SURFACTANT(S) to ensure product performance?

- ◯ Yes
- ◯ No

If yes, please explain

14. Did your agency encounter issues regarding the use of GH products and SEED COMPANY WARRANTIES?

- ◯ Yes
- ◯ No

If yes, please explain

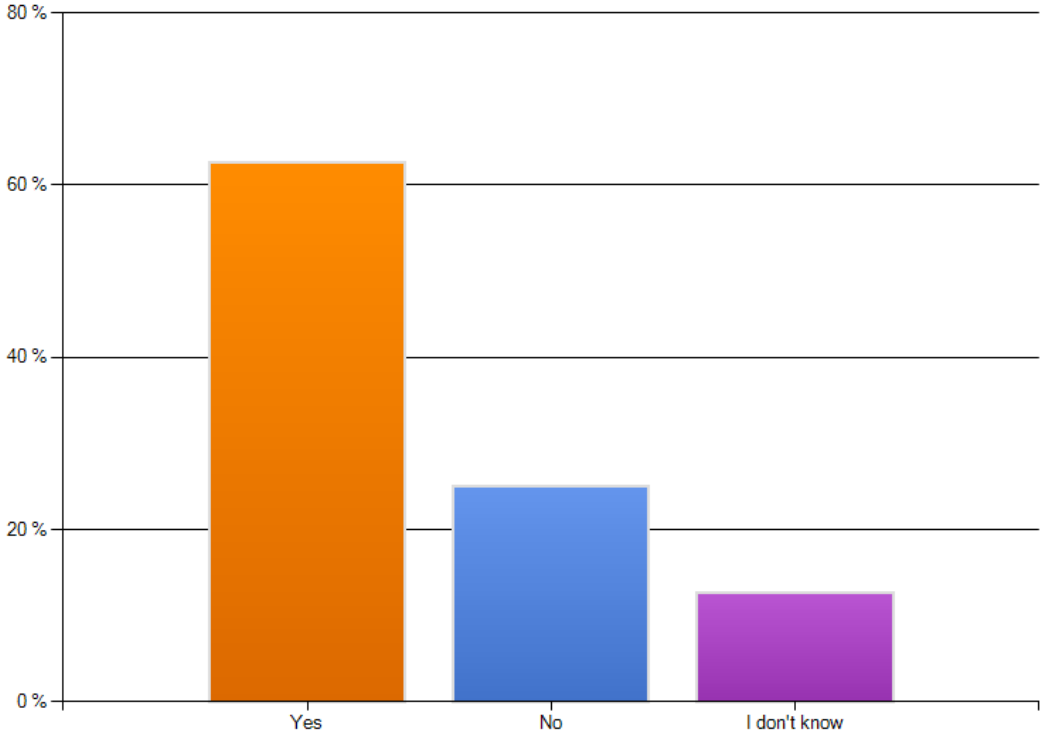
15. Does your agency plan to use GH in the future?

- ☐ Yes
- ☐ No
- ☐ Uncertain

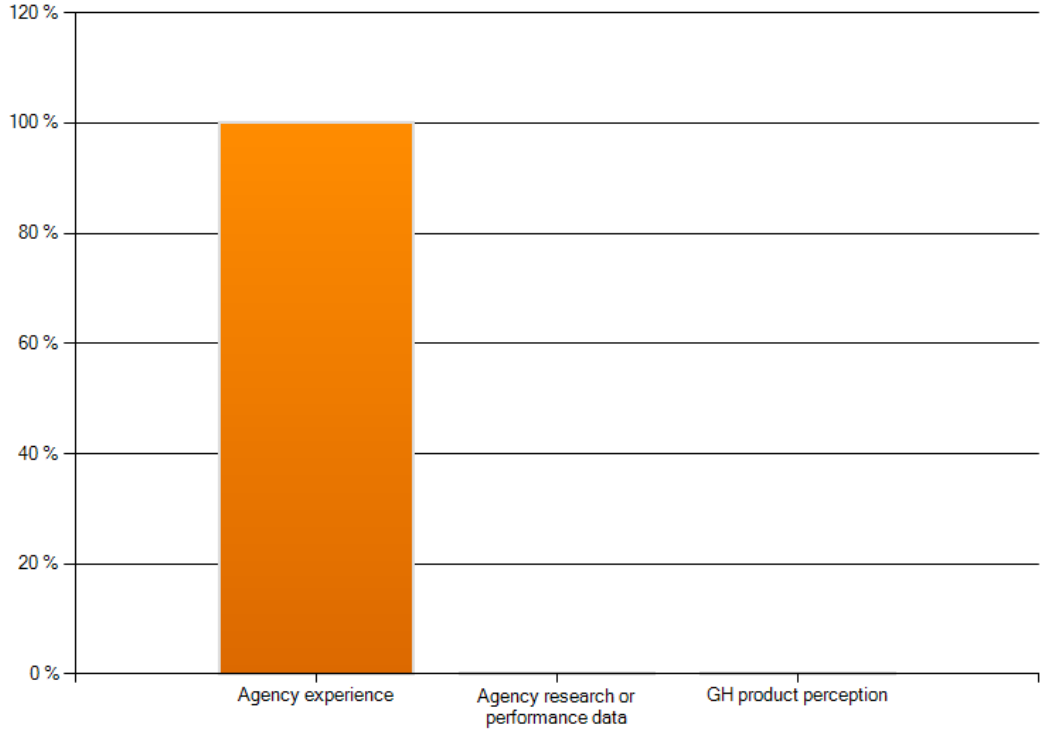
16. Thank you for taking time to complete this survey. Please use the following box to provide any further comments.

APPENDIX C:
ONLINE SURVEY RESULTS

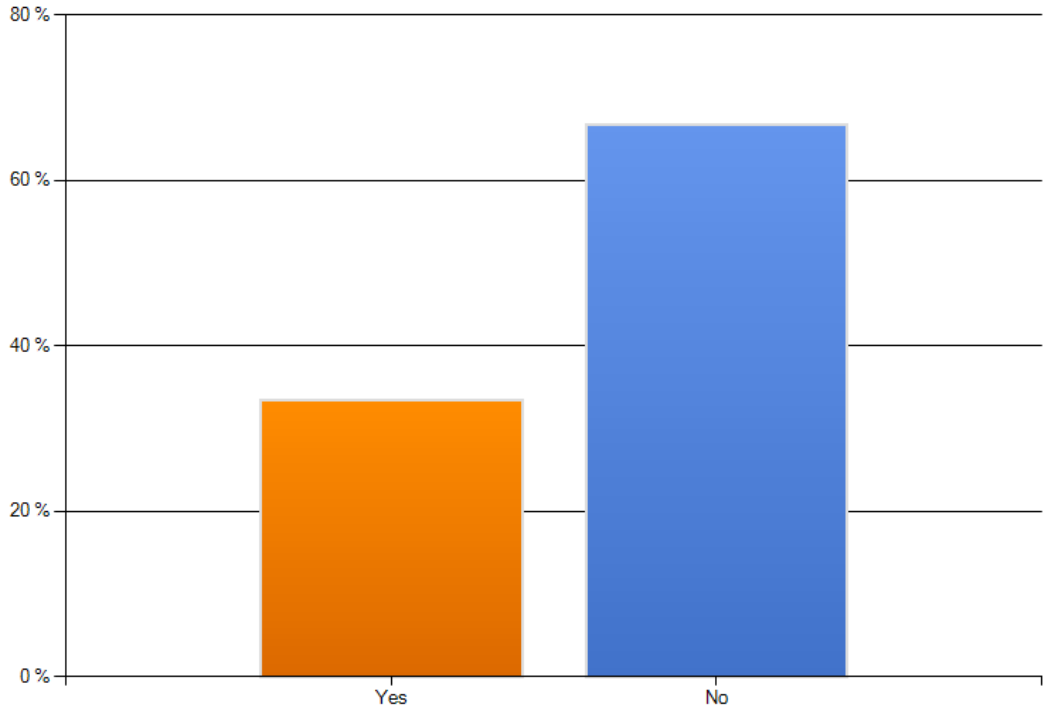
Has your agency ever used or currently using GENERIC HERBICIDE (GH) products?



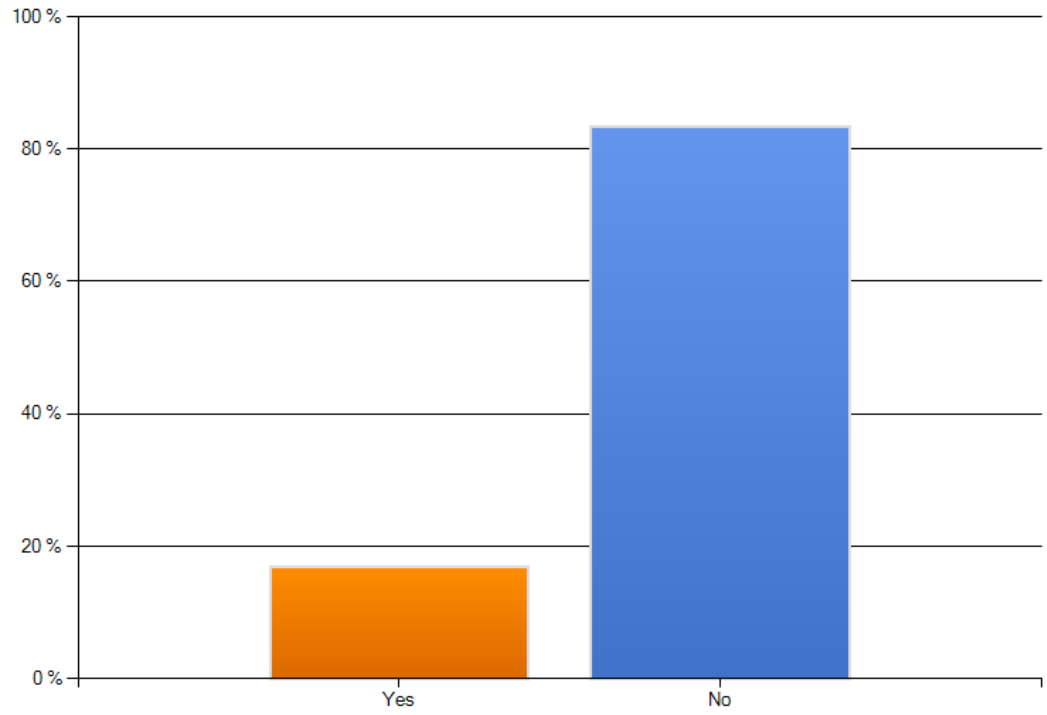
Is the reason your agency does NOT use GH products based on any of the following?



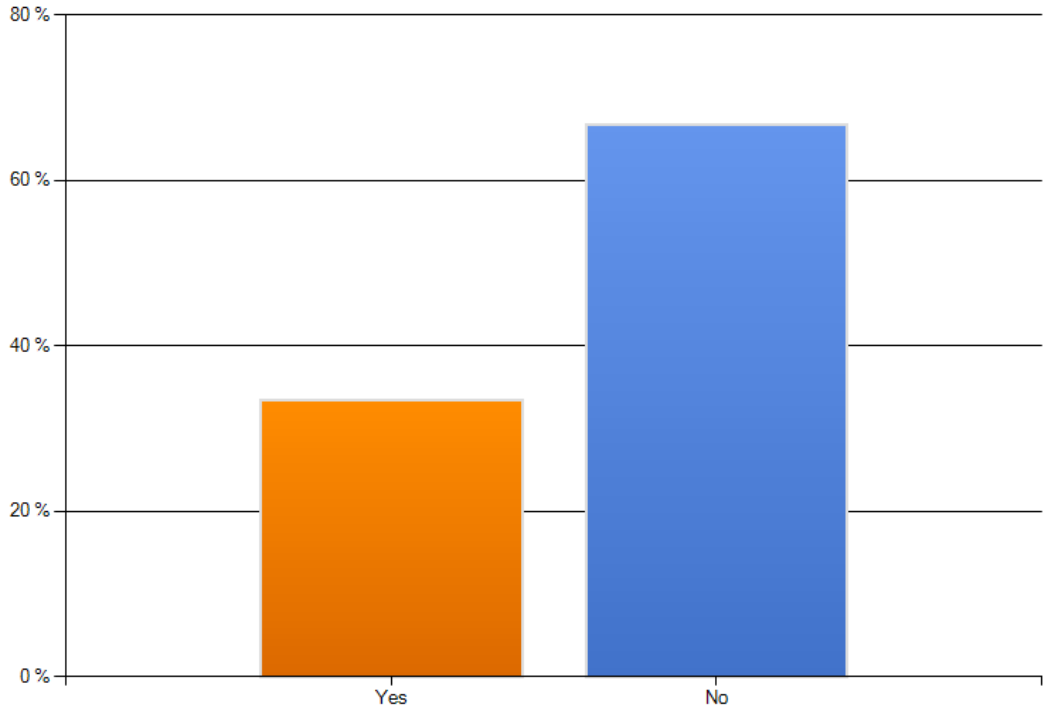
Did the use of GH products require different preparation or application EQUIPMENT than the BH products?



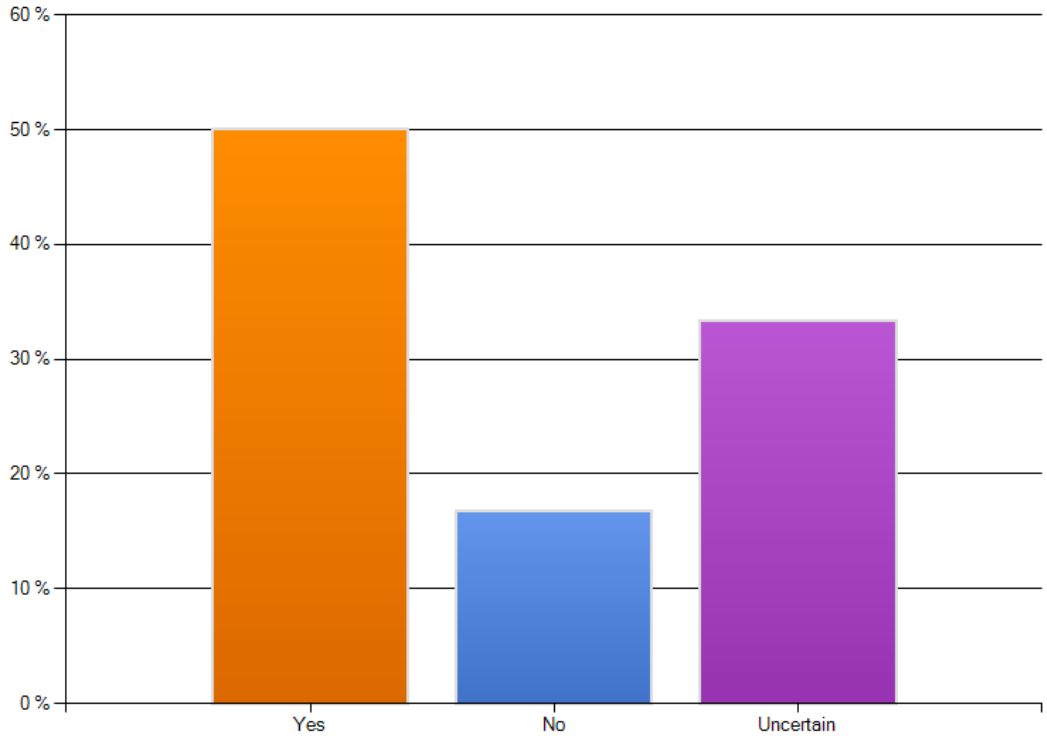
Did the use of GH products require any additional SURFACTANT(S) to ensure product performance?



Did your agency encounter issues regarding the use of GH products and SEED COMPANY WARRANTIES?



Does your agency plan to use GH in the future?



APPENDIX D:
PRODUCT LABELS OF SELECTED GENERIC AND BRANDED HERBICIDE PRODUCTS

Glyphosate Products

- Roundup PROMAX (Branded)
- Roundup Pro (Branded)
- Glyphosate 4 (Generic)
- Eraser (Generic)

Metsulfuron Methyl Products

- Escort XP (Branded)
- MSM 60DF (Generic)

Clopyralid Products

- Transline (Branded)
- Clyporalid 3 (Generic)

Appendix D-1. Glyphosate Product Labels

Roundup PROMAX® Herbicide

The complete broad-spectrum postemergence professional herbicide for non-crop, industrial, turf and ornamental weed control.

Complete Directions for Use

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION IS LIKELY TO RESULT.

EPA Reg. No. 524-579 2010-1

GROUP	9	HERBICIDE

Read the entire label before using this product.

Use only according to label instructions.

Not all products listed on this label are registered for use in California. Check the registration status of each product in California before using.

Read the LIMIT OF WARRANTY AND LIABILITY statement at the end of the label before buying or using. If terms are not acceptable, return at once unopened.

THIS IS AN END-USE PRODUCT. MONSANTO DOES NOT INTEND AND HAS NOT REGISTERED IT FOR REFORMULATION OR REPACKAGING.

PRODUCT INFORMATION

1.0 INGREDIENTS

ACTIVE INGREDIENT:	
*Glyphosate, N-(phosphonomethyl)glycine, in the form of its potassium salt	48.7%
OTHER INGREDIENTS:	51.3%
	100.0%

*Contains 660 grams per liter or 5.5 pounds per U.S. gallon of the active ingredient glyphosate, in the form of its potassium salt. Equivalent to 540 grams per liter or 4.5 pounds per U.S. gallon of the acid, glyphosate.

This product is protected by U.S. Patent No's. 5,668,085 and 6,365,551. Other patents pending. No license granted under any non-U.S. patent(s).

Roundup PRO® Herbicide

The complete broad-spectrum postemergence professional herbicide for industrial, turf and ornamental weed control.

Complete Directions for Use

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION IS LIKELY TO RESULT.

EPA Reg. No. 524-475 2010-1

GROUP	9	HERBICIDE

Read the entire label before using this product.

Use only according to label instructions.

Not all products listed on this label are registered for use in California. Check the registration status of each product in California before using.

Read the "LIMIT OF WARRANTY AND LIABILITY" statement at the end of the label before buying or using. If terms are not acceptable, return at once unopened.

THIS IS AN END-USE PRODUCT. MONSANTO DOES NOT INTEND AND HAS NOT REGISTERED IT FOR REFORMULATION. SEE INDIVIDUAL CONTAINER LABEL FOR REPACKAGING LIMITATIONS.

1.0 INGREDIENTS

ACTIVE INGREDIENT:	
*Glyphosate, N-(phosphonomethyl)glycine, in the form of its isopropylamine salt	41.0%
OTHER INGREDIENTS (including surfactant):	59.0%
	100.0%

*Contains 480 grams per liter or 4 pounds per U.S. gallon of the active ingredient glyphosate, in the form of its isopropylamine salt. Equivalent to 356 grams per liter or 3 pounds per U.S. gallon of the acid, glyphosate.

This product is protected by U.S. Patent Nos. 5,683,958; 5,703,015; 6,063,733; 6,121,199; 6,121,200. No license granted under any non-U.S. patent(s).

VegetationManager®

GLYPHOSATE 4

SPECIMEN LABEL

ACTIVE INGREDIENT:
*Glyphosate, N-(phosphonomethyl)
glycine, in the form of its isopropylamine salt 41.0%
OTHER INGREDIENTS: 59.0%
TOTAL 100.0%

*This product contains 480 grams per liter or four pounds per U.S. gallon of glyphosate—the active ingredient—in the form of its isopropylamine salt. This equals 356 grams per liter, or three pounds per U.S. gallon of the acid, glyphosate.

EPA Reg. No. 73220-6-74477 EPA Est. No. 37429-GA-1

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d) (4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

USER SAFETY RECOMMENDATIONS:

Users should:
• Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
• Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put

Surrender brand

ERASER
Systemic Weed & Grass Killer

Avoid herbicide contact with foliage, green stems, exposed non-woody roots or fruit of crops, desirable plants and trees because severe injury or destruction may result.

- 41% Concentrate with Surfactant

ACTIVE INGREDIENT:	
*Glyphosate, N-(phosphonomethyl)glycine, in the form of its isopropylamine salt	**41.0%**
INERT INGREDIENTS	**59.0%**
TOTAL	**100%**

* Contains 480 grams per liter or 4 pounds per U.S. gallon of the active ingredient glyphosate, in the form of its isopropylamine salt. Equivalent to 365 grams per liter or 3 pounds per U.S. gallon of the acid, glyphosate.

Appendix D-2. Metsulfuron Methyl Product Labels

GROUP	2	HERBICIDE

DuPont™ Escort® XP

herbicide

Dry Flowable

Active Ingredient	*By Weight*
Metsulfuron methyl Methyl 2-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]-carbonyl]amino]sulfonyl]benzoate	60%
Other Ingredients	40%
TOTAL	100%

EPA Reg. No. 352-439 EPA Est. No. _____

ALLIGARE

MSM 60

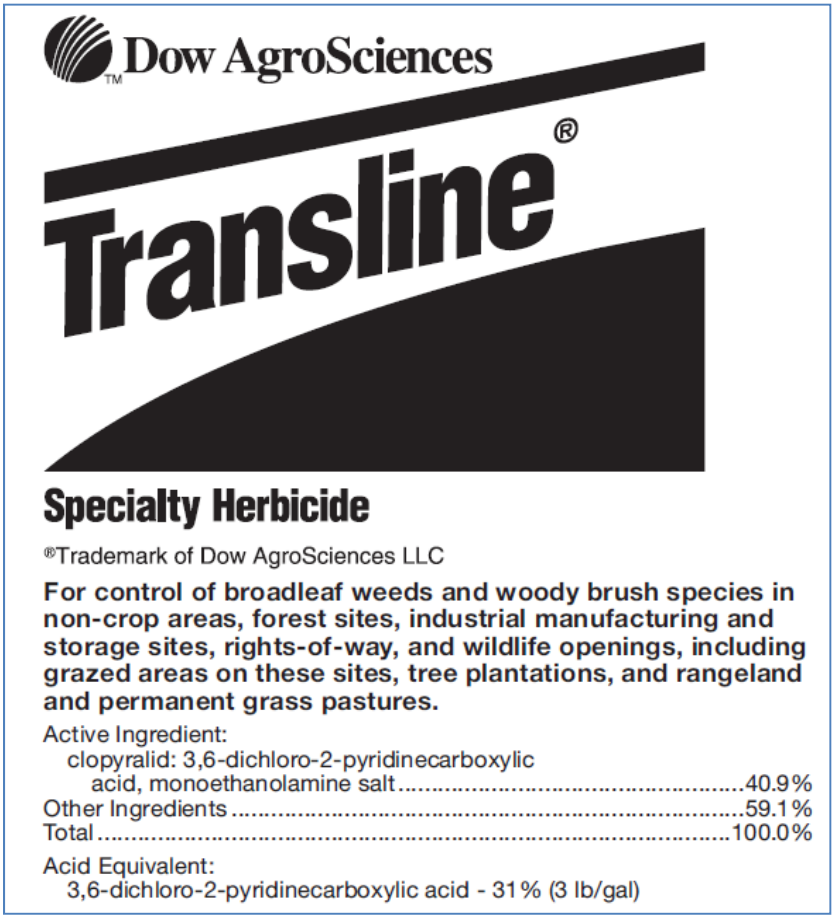
GROUP 2 HERBICIDE

SPECIMEN LABEL

ACTIVE INGREDIENT:
Metsulfuron Methyl
Methyl 2-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]-carbonyl]amino]
sulfonyl]benzoate 60.0%
OTHER INGREDIENTS: 40.0%
TOTAL: 100.0%

EPA Reg. No. 81927-7 EPA Est. No. 81134-CHN-001

Appendix D-3. Clopyralid Product Lables



Dow AgroSciences

Transline®

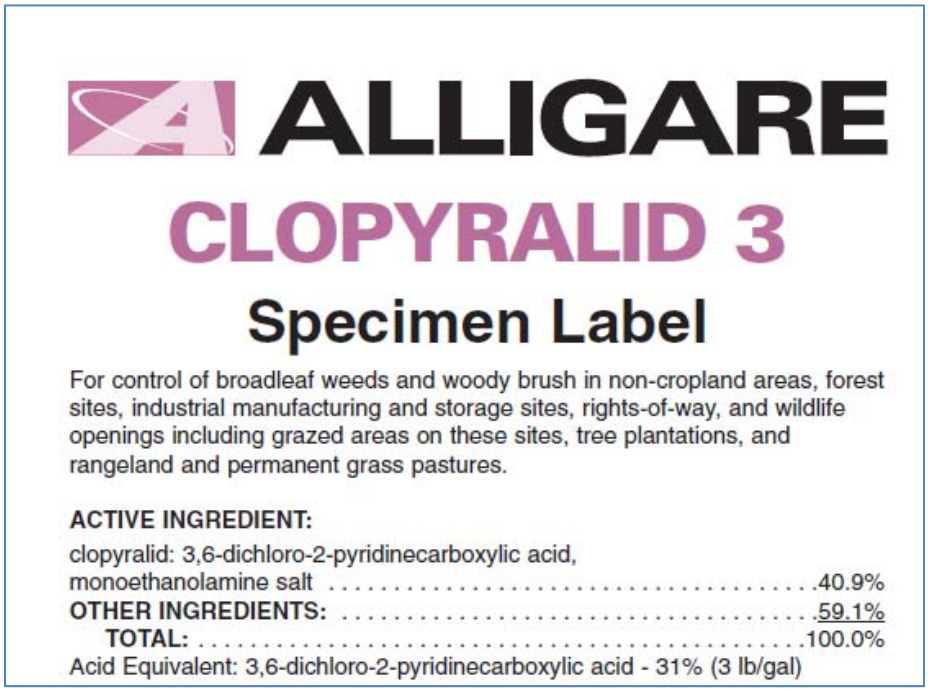
Specialty Herbicide

®Trademark of Dow AgroSciences LLC

For control of broadleaf weeds and woody brush species in non-crop areas, forest sites, industrial manufacturing and storage sites, rights-of-way, and wildlife openings, including grazed areas on these sites, tree plantations, and rangeland and permanent grass pastures.

Active Ingredient:
clopyralid: 3,6-dichloro-2-pyridinecarboxylic acid, monoethanolamine salt.....40.9%
Other Ingredients.....59.1%
Total.....100.0%

Acid Equivalent:
3,6-dichloro-2-pyridinecarboxylic acid - 31% (3 lb/gal)



ALLIGARE

CLOPYRALID 3

Specimen Label

For control of broadleaf weeds and woody brush in non-cropland areas, forest sites, industrial manufacturing and storage sites, rights-of-way, and wildlife openings including grazed areas on these sites, tree plantations, and rangeland and permanent grass pastures.

ACTIVE INGREDIENT:

clopyralid: 3,6-dichloro-2-pyridinecarboxylic acid, monoethanolamine salt 40.9%
OTHER INGREDIENTS: 59.1%
TOTAL: 100.0%
Acid Equivalent: 3,6-dichloro-2-pyridinecarboxylic acid - 31% (3 lb/gal)