2008 Report on
The Evaluation of Herbicide Tank Mix Compatibility

Project 2157: Section 3

By

Craig Evans
Extension Associate

Doug Montgomery
Extension Associate

and

Dr. Dennis Martin
Extension Turfgrass Specialist

Oklahoma State University
358 Agriculture Hall
Stillwater, OK 74078-6027

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 views of the Oklahoma Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification or regulation.

In order that the information in this publication may be more useful, it was necessary to use trade names of products, rather than chemical names. As a result, it is unavoidable in some cases that similar products that are on the market under other trade names may not be cited. No endorsement of products is intended nor is criticism implied of similar products that are not mentioned.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Director of Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Dean of the Division of Agricultural Sciences and Natural Resources. 12/2008.

TABLE OF CONTENTS

Introduction

The Oklahoma Department of Transportation (ODOT) follows compatibility testing outlined in the Approved Herbicide and Adjuvant List (AHAL) Criteria published in September 2007. Compatibility testing helps ODOT protect itself from unknown as well as potentially costly incompatibility between new or reformulated herbicides and adjuvants. Undesirable consequences of incompatibility can include product settling, layer formation, globule formation or formation of precipitants in the spray tank. When these problems occur, they may prevent the proper application of incompatible mixtures to highway rights-of-way. Use of incompatible mixtures may also cause poor weed control directly or indirectly due to incorrect application rates of herbicides to the target area. Generally speaking, most active ingredients (a.i.) that actually control vegetation are thoroughly investigated by the U.S. Environmental Protection Agency (EPA) prior to registration. However, inert ingredients and other chemical additives are trade secrets and are not easily identified as to whether they adversely affect any products ODOT currently uses in their Integrated Roadside Vegetation Management (IRVM) programs.

As a result of these preventative investigative protocols, Oklahoma State University Roadside Vegetation Management personnel annually investigate products prior to their incorporation into ODOTs IRVM program. The importance of this research is further highlighted by the amount of acreage treated by ODOT for vegetation management. Herbicide acreage treated can range from a recent high of approximately 112,000 acres in 2007 to approximately 96,000 acres treated in 2008. Assuming a 30 gallon per acre carrier rate, this equates to approximately 2,880,000 gallons of herbicide/carrier tank mixture. A major incompatibility with key products might result in significant amounts of unusable tank mix, possibly hazardous waste and an inefficient use of maintenance funds.

Research Objective

The objective of this research remains the evaluation of readily created herbicide/adjuvant tank mixes for visually detectable physical incompatibility using an industry standard jar test.

In 2008, one “branded” product, Ranger Pro® (a Monsanto generic glyphosate product) was evaluated for herbicide/adjuvant tank mix compatibility so as to possibly include it on the 2009 AHAL for use by ODOT maintenance managers. Ranger Pro® is specifically labeled only for the utility and rights-of-way markets (Appendix A.) At the request of Division 1 maintenance engineers, Ranger Pro® was investigated in order to provide ODOT maintenance managers a reduced cost glyphosate product that would provide a more specific use label than generic glyphosate products such as Honcho Plus® which was a generic glyphosate product that was bid in 2008. Distributors that were contracted by the State of Oklahoma to supply Honcho Plus® to the ODOT in 2008

instead opted to sell Honcho Plus® to buyers in the agriculture market who were willing to pay substantially more than the contracted ODOT price for limited supplies of the glyphosate product. As a result, in 2008, ODOT had only one single source of contracted glyphosate, Roundup Pro Concentrate®. The cost of Roundup Pro Concentrate® was significantly more than the anticipated alternative generic products.

Ranger Pro® already contains surfactant, consequently, compatibility testing focused upon the interaction of Ranger Pro® with ODOTs standard, single bid drift control product, Detain II® (a polyacrylamide copolymer) that is required in each broadcast application of herbicide utilized by ODOT.

Materials & Methods

Industry standard spray carrier rates of 30 gallons per acre were simulated in the experiment.

Clear, clean, unused 1-liter soda bottles were filled with 500 ml of deionized water. Deionized water was obtained through Oklahoma State University laboratories and is characterized by a pH of 4.2 with minimal amounts of cations and anions (see Appendix B). The lack of calcium and magnesium resulted in classification of this carrier as "soft". The appropriate herbicide amounts were added to each bottle to represent a maximum recommended broadcast rate for ODOT applications, 32 fl. oz./acre (OSU Publication E-958: *Suggested Herbicides for Roadside Weed Problems*, October, 2008).

Experimental conditions were maintained under reasonably controlled environmental conditions where air temperatures averaged 72.4 ^{o}F and deionized water temperatures averaged 73.2^{o} F. Air temperature fluctuations ranged from 71.4 ^{o}F to 73.2^{o}F. Deionized water temperature fluctuations ranged from 72.0 ^{o}F to 74.0 ^{o}F. Temperature readings were taken hourly throughout the course of the experiments using a mercury-in-glass thermometer (accuracy $\pm$0.2 ^{o}F, precision $\pm$0.1 ^{o}F).

Tank mix treatments were evaluated at three separate stages (see Appendix C) to determine if any incompatibility complexes were initiated. Once all herbicide/adjuvant components were placed in the plastic bottle, the bottle was inverted slowly 10 times to mix the components. Assessment was made immediately upon mixing. After 30 minutes the bottle was checked for any incompatibility complexes before being inverted slowly for 10 times. Upon this mixing effort, a final evaluation was performed for incompatibility. Four questions were asked at each stage of the evaluation (see Appendix D) to assess the major visual incompatibilities that are commonly found. The visual physical incompatibilities for which the herbicide/adjuvant tank mix was assessed included: formation of precipitates, layering, change in flocculation and excessive foaming. Bottles were backlit with strong light sources to make incompatibilities more evident, if present. Digital images were recorded for all herbicide/adjuvant tank mix combinations during the third replication.

Results & Discussion

No significant incompatibilities were observed in any of the replicated combinations of Ranger Pro® and Detain II®. Our testing can be considered to represent a conservative approach. We are confident that this testing method would detect

incompatible tank mix combinations that would be problematic to the ODOT RVM Manager. We do not feel that Ranger Pro® combined with any of the traditionally utilized ODOT herbicide/adjuvant tank mixes would cause any problems to ODOT personnel as long as labeled directions are followed and characteristics of water carrier sources are not extreme.

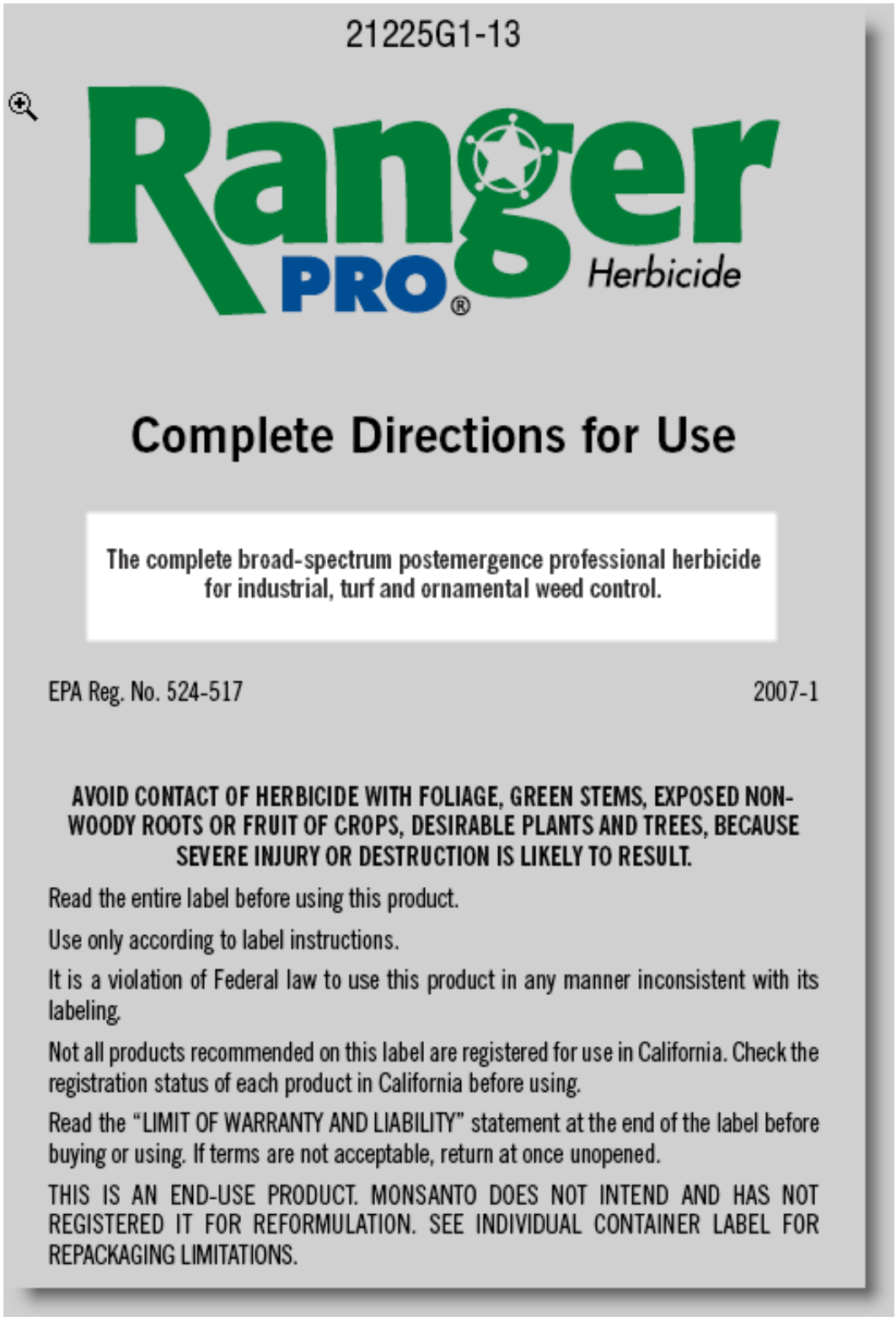
Summary and Recommendations

OSU Roadside Vegetation Management Program compatibility testing of Ranger Pro® in combination with Detain II® did not detect any significant or major visibly discernable physical incompatibility. The Detain II® drift control product is available through the state herbicide contract.

Ranger Pro® and Detain II®, combined at labeled rates, would not be expected to create any tank mix combination that would be unusable, nor create any hazardous waste. Our compatibility testing is only for physical incompatibility that can be detected via a visual test. ODOT herbicide applicators are encouraged to read all herbicide labeled information concerning water carrier issues and to be familiar with the water source they are using. ODOT applicators can reference the OSU RVM Programs report “2005 Evaluation of ODOT Water Quality Characteristics for Suitability in Herbicide Spray Applications” or the ODOT Roadside Vegetation Management Guidelines, 3rd Ed. 2006, to determine specific characteristics of water sources tested. Additionally, we would encourage periodic testing of water sources especially if water sources change from previous sources.

We are formally recommending that Ranger Pro®, tested in this study, be included in the next ODOT Approved Herbicide & Adjuvants List (AHAL).

Appendix A: Ranger Pro® Label Stating Use Sites



21225G1-13

Ranger PRO® Herbicide

Complete Directions for Use

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

EPA Reg. No. 524-517 2007-1

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

Read the entire label before using this product.

Use only according to label instructions.

It is a violation of Federal law to use this product in any manner inconsistent with its labeling.

Not all products recommended 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.

Appendix B: Deionized Water Analytical Laboratory Report

OKLAHOMA COOPERATIVE EXTENSION SERVICE

SOIL, WATER & FORAGE ANALYTICAL LABORATORY

Division of Agricultural Sciences and Natural Resources • Oklahoma State University
Plant and Soil Sciences • 045 Agricultural Hall • Stillwater, OK 74078
Email: soiltesting@okstate.edu
Website: www.soiltesting.okstate.edu

WATER QUALITY REPORT

DOUG MONTGOMERY
ROADSIDE VEGETATION MGMT PROGRAM
358 AG HALL

STILLWATER, OK 74078

Name:

Location:

Lab ID No.: 512347
Customer Code: 216
Sample No.: 1
Received: 10/10/2008

TEST RESULTS

---------- Cations ----------		---------- Anions ----------		---------- Other ----------	
Sodium (ppm)	2	Nitrate-N (ppm)	< 1	pH	4.2
Calcium (ppm)	1	Chloride (ppm)	1	EC (µmhos/cm)	11
Magnesium (ppm)	0	Sulfate (ppm)	0	Fe	0.01
Potassium (ppm)	1	Boron (ppm)	0.02	ICAP-P (ppm)	0.06

---------- Derived Values ----------		-------- Derived Values(cont'd) ----------	
Total Soluble Salts (TSS in ppm)	8	Soduim Percentage	51.1%
Sodium Adsorption Ratio (SAR)	0.4	Hardness (ppm)	4
Potassium Adsorption Ratio (PAR)	0.1	Hardness Class	Soft

INTERPRETATION AND REQUIREMENTS FOR *Irrigation Water*

The total soluble salt and sodium content of this water are low enough that no problem should result from its use.

Signature

Appendix C: Procedures for Conducting Herbicide/Adjuvant Compatibility Testing

1. Mix all herbicides together in the simulated spray tank (bottle) first, before attempting to add any adjuvant. The mixing order of products should follow the guidelines given below.

Mixing order for herbicides:
a. Ammonium sulfate (AMS)
b. dry herbicides
c. liquid solubles
d. liquid emulsifiables

Mixing should occur by slowly inverting bottle 3 or 4 times after each product is added. This should be adequate to mix all liquids but dry herbicides will require repeating the inversion process several more times over a 1-3 minute period or until all dry herbicide prills are visibly dispersed. Inverting bottles should be performed to prevent excessive foaming if at all possible. All herbicides & AMS should be thoroughly mixed before attempting the addition of any adjuvants being tested.

2. Add the appropriate adjuvants to the herbicide mixture one at a time followed by slowly inverting the mixture 10 times. Evaluate the mixture immediately and move on to the next adjuvant, repeating the process. Once the first mixture is evaluated, make a note of the time on the score sheet. Once all evaluations are made with a particular herbicide treatment, allow the bottles to set undisturbed for 30 minutes (or as close as possible).

3. After 30 minutes evaluate each of the bottles for the 2nd time. It is acceptable to pick up the bottles, but this should be done carefully so as not to disturb the mixture. After evaluation, place each bottle down undisturbed. It might be helpful to hold the mixture with a bright light (light bulb, window) behind the bottle to backlight the mixture making possible incompatibilities more visible. When the last mixture is evaluated proceed immediately to the 3rd evaluation.

4. The 3rd and final evaluation occurs by slowly inverting the first bottle 10 times followed by evaluation.

5. Each herbicide treatment will have 3 evaluation sheets, one sheet for each evaluation timing. When evaluations are completed, staple the 3 evaluation sheets together.

Appendix D: Compatibility Study Data Collection Form

Herbicide Treatment:													Evaluation Step: 1st 2nd 3rd			
Evaluator:							Study/Replication Number:						Date:			
Adjuvant	Supplier	1. Were precipitates formed?					2. Were separate layers formed?			3. Did herbicide mixture flocculate?			4. Was there a change in foaming?			5. Other?
		No	flakes	colored globules	clear globules	sludges	No	suspend	settled	No	suspend	settled	No change	More	Less	
Detain II	Estes															