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Program Manager
USDA/AMS/TM/NOP
Room 4008-So, Ag Stop 0268
1400 Independence Ave., SW
Washington, DC 20250

Petition to Amend the National List

This package contains two copies of a petition to the National Organic Standards Board to add the naturally occurring soap "ammonium nonanoate" to § 205.601 of the National List as a synthetic substance for use as an herbicide in organic food production. The petition is also being submitted on four identical DVD's.

The printed petition and the DVD's include all of the information required by the guidelines for submission of a petition to the NOP as published in the Federal Register, Vol. 72, No. 11, pges 2167 - 2170, a copy of which is attached. Numerous references are made to public literature in the petition. Copies of these references are included as Exhibits A - Q in both the printed and recorded forms.

We appreciate the opportunity afforded us to submit this petition and are available to answer any questions regarding the petition text or any of the Exhibit contents.

Respectfully yours,

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12-28-2009

01-06-10A08:04 CFMD

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Petition

To

National Organic Standards Board

December 22, 2009

Petitioners:

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Action Requested:

We hereby petition the NOSB to add the naturally occurring soap "ammonium nonanoate" to § 205.601 of the National Organic Program as a synthetic substance allowed for use as an herbicide in organic food crop production.

Specifically, the action requested is the allowance for spray application of water solutions of this herbicidal soap to control weeds as follows: 1) prior to planting food crops, 2) directed spray at the base of grape vines and fruit trees, 3) as shielded or directed sprays to the soil surface between food crop rows and onto the edge of plastic film mulch including the adjacent soil.

Justification:

Ammonium nonanoate (CAS# 63718-65-0) is the chemical combination of ammonia and nonanoic acid (a fatty acid) to form a salt. By definition, soaps are salts of fatty acids. Therefore, ammonium nonanoate is soap. The NOSB affirmed this at the Nov. 2008 NOSB meeting in Washington when it was added to the National List for non-food weed control.

Ammonium nonanoate is a naturally occurring soap. It forms in the environment when ammonia, a substance constantly being generated from the decomposition of nitrogen-containing waste, comes in contact with nonanoic acid that volatilizes from leaf surfaces of most plants (washes onto soil from rain), certain flowers and the biodegradation of fats. Both are widespread in air, water and ground (see pg. 1- 9 of Exhibit A & pg. 12 - 14 of Exhibit B).

The EPA estimates that salts of fatty acids, like ammonium nonanoate, biodegrade in the environment in less than 24 hrs. (Pg. 10, Exhibit C). Thus, it does not accumulate in nature and cannot be isolated in quantities large enough for isolation for agricultural purposes. A synthetic route is the only feasible method for its production for use as a pesticide.

Section 6517 (National List) of the Federal Organic Foods Production Act (OFPA) that defines the permitted use of certain synthetic substances in organic farming is reproduced below. Two paragraphs, (A)(iii) and (B)(i) are pertinent to this petition.

(1) Exemption for Prohibited Substances. The National List may provide for the use of substances in an organic farming or handling operation that are otherwise prohibited under this chapter only if

(A) the Secretary determines, in consultation with the Secretary of Health and Human Services and the Administrator of the Environmental Protection Agency, that the use of such substances (i) would not be harmful to human health or the environment;

(ii) is necessary to the production or handling of the agricultural product because of unavailability of wholly natural substitute products*; and*
***(iii)** is consistent with organic farming and handling;*

<u>(B) the substance</u>

(i) is used in production and contains an active synthetic ingredient in the following categories: copper and sulfur compounds; toxins derived from bacteria; pheromones, soaps, horticultural oils, fish emulsions, treated seed, vitamins and minerals; livestock paraciticides and medicines and production aids including netting, tree wraps and seals, insect traps, sticky barriers, row covers, and equipment cleansers;

The following two points based on the aforementioned regulation in Section 6517 provide clear reasons for the listing of ammonium nonanoate for weed control around organic food crops:

<u>Point 1</u>.

The wholly natural products now available to organic farmers as permitted in Sec. (A)(iii) are inadequate to effectively control weeds under the provisions of § 205.601. Some organic farmers have returned to conventional farming or turned to livestock/milk production because they were unable to obtain economically viable weed control due to the poor performance and high cost of

NOP- allowed weed control methods.

Test studies of wholly natural herbicidal substances listed by OMRI for organic food use have been conducted at the Univ. of California (Exhibit D & E), Oklahoma State (Exhibit F), Cornell, Michigan State, Univ. of Delaware (Exhibit G), Penn State University (Exhibit H), North Dakota State (Exhibit I), Purdue University, the USDA Test Facilities in Lane, Oklahoma (Exhibit J) and others. These academic studies show that the allowed natural substitutes have relatively low efficacy, even at high application rates. Two of the substances tested, clove oil and lemongrass oil, are available only from foreign sources with the potential risk of an unreliable supply.

When ammonium nonanoate soap was included in the academic studies, it was a superior herbicide when compared to the NOP-allowed wholly natural products. Ammonium nonanoate controlled a larger variety of weeds, larger weeds and at lower application rates. Note that in all test cases, a surfactant was added to the tested herbicides, except ammonium nonanoate, which is a surfactant.

Natural vinegar (max.8% acetic acid) is ineffective in all tests. Higher strength acetic acid (up to 10 - 30%) that is made by evaporating water from vinegar is better but it is available from only limited sources and cannot be EPA registered as an active ingredient. Vinegar can be mixed with clove oil or citric acid but the results are still inadequate. Moreover, it appears to be unrecognized by the organic community that acetic acid use falls under OSHA guidelines that controls human exposure. Both OSHA and NIOSH inhalation limits are at or below 10 ppm in breathed air for 10% or higher acetic acid (Exhibit K). This is a matter of safety to the user or others when acetic acid is applied to weeds at an effective strength as a spray. Higher strength acetic acid (>10%) is very corrosive to human tissue (Exhibit K), to metals including stainless steel.

Clove oil, (FIFRA(25)(b) listed), an essential oil that is extracted from unopened flower buds in the Myrtaceae or Myrtle family grown in Asia and South America and sold as Matran™ , controls only small weeds at high application rates (Exhibit H). Since it is water insoluble, it can only be utilized as an herbicide in a water emulsion.

Lemongrass oil (FIFRA(25)(b) listed) is imported from India and many other countries. It is obtained from various kinds of lemongrass by collecting the grass, steeping the grass in water followed by steam distillation. The oil distills with the boiled water and separates as a water insoluble layer from the condensed water. Lemongrass oil varies in composition, depending on its source; so different batches may have different efficacy and different impurities. Like clove oil, it must be mixed with emulsifiers to allow it to be applied to weeds as a water emulsion. Its effectiveness versus ammonium nonanoate soap is shown in Exhibit H where ammonium nonanoate is listed as "Racer®" and lemongrass oil as "Greenmatch EX™.

D-limonene (orange oil) is the active ingredient in an EPA registered herbicide that is OMRI Listed® for weed control around food crops. It is classified as an inert for food application under CFR §180.919. It must be emulsified for use as a spray. In comparison tests against water solutions of ammonium nonanoate, commercial d-limonene based herbicide had no effect on weeds that ammonium nonanoate solution destroyed within 24 hrs. (Petitioner data). Also see Exhibits D & H where a d-limonene herbicide is identified as "Natures Avenger™".

None of the substances described above that are considered organic are part of the normal human diet (except for the food use of 6% vinegar). "The fatty acids are a significant part of the daily diet, for they occur in dietary lipids which usually constitute about 90 grams in a day's diet" (Exhibit C, pg. 9). When salts of fatty acids are ingested (whether sodium, potassium or ammonium) they are immediately converted by stomach acid to the parent fatty acid. Thus, any soap residue from a natural or intentional source on food crops, is metabolized in the body as a fatty acid.

Point 2.

Section 6517 (B)(i) of the OFPA lists the categories of synthetic substances that may be considered for use in organic farming. Soap is one of them.

Fatty acids are in all edible vegetable and animal fats. Soaps have been used for cleaning purposes for centuries. Millions of tons of soap salts are used by humans each year for personal hygiene, laundering, in kitchens, etc. (See http://www.heraproject.com/RiskAssessment.cfm). But despite this, soaps are not allowed as herbicides for food use under § 205.601 (7); (7)(b); and (7)(b)(1) of the NOP but soaps are allowed "on" organic food crops as insecticides under the usual restrictions. Therefore, ammonium nonanoate soap presumably could be used on organic food crops as an insecticide (if EPA registered as such) but "not around" organic food crops as an herbicide. The reasoning behind this inconsistency is not clear. The EPA in Exhibit C (pg.18) states that ammonium soaps and potassium soaps have the same risk to the environment, i.e., are equivalent. Ammonium soaps are allowed as animal repellants in the NOP but no contact with soil or edible portion of crops is permitted although the evidence in this petition in Exhibits A and B can only be interpreted that ammonium soaps are already present in the soil and on crops.

The following is a quote from Exhibit L entitled "Ammonium Nonanoate" (PC code 031802) from the EPA Biopesticides and Pollution Prevention Division (BPPD):

"Ammonium nonanoate is closely related to other salts of fatty acids known as soap salts. Toxicology and environmental data requirements for this biochemical herbicide product were waived, primarily via the Agency's Reregistration Eligibility Document (RED) for Soap Salts. The RED (EPA-738-F-92-013, September, 1992) concludes that no risks to human health are expected from the use of ammonium salts of higher fatty acids (C8-C18 saturated and C18 unsaturated) based on their low toxicity and the fact that residues from pesticide uses are not likely to exceed the levels of naturally-occurring or intentionally-added fatty acids in commonly-eaten foods. Ammonium salts of fatty acids are rapidly biodegraded in the environment, and are expected to be only minimally toxic to nontarget organisms, with the exception of aquatic invertebrates. Appropriate precautionary labeling of end use products containing ammonium salt will further minimize potential exposure and mitigate risk to humans and nontarget organisms."

"The Agency has considered ammonium nonanoate in light of relevant safety factors in the Food Quality Protection Act (FQPA) of 1996 and under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and determined there will be no unreasonable adverse effects from the use of this product. The Agency has considered available data and other factors, including the natural occurrence of soap salts, their common use as food items, and the lack of reported adverse effects, and believes that end use products containing ammonium nonanoate, can be used without causing unreasonable adverse effects to humans or the environment."

The EPA registered ammonium nonanoate as a biopesticide on September 21, 2006. Please note that the EPA states that any residues of intentionally added ammonium nonanoate on food are not likely to exceed the levels that are there naturally.

On July 9, 2008, all ammonium salts of fatty acids, including ammonium nonanoate, were granted an exemption from a residue tolerance allowing ammonium nonanoate to be EPA registered for food use (Exhibit M).

Registration:

A solution of 40 parts of ammonium nonanoate in 60 parts of water is registered as a bioherbicide by the EPA as Registration No. 79766-1. The name of this herbicide is Racer®. A complete label giving safety precautions, weeds affected and directions for use is attached (Exhibit N). An MSDS for Racer is also attached (Exhibit O). Racer® Concentrate is registered as a bioherbicide in California (Exhibit P) with "For Organic Production" on the label. The data submitted for Florida registration is attached as Exhibit Q as required by the directions for NOSB petitions. Racer® is OMRI-Listed® as an herbicide for non-food use as approved by the NOSB.

Ammonium nonanoate solution, like all herbicides acceptable under the conditions of NOP § 205.206(e), is a contact herbicide that requires full weed plant coverage to be effective as an herbicide. Thus, the spray rates depend on the type and size of weed and the water dilution factor. Small weeds (less than 3 inches) require less spray than larger weeds. The rates may be as low as 30 gallons of a 10% vol/vol water dilution/acre, while larger weeds require a stronger solution and a greater spray rate/acre. The spray rate for spot treatments, hooded sprayers and weed control along plastic mulch also depends on weed size and the ability to cover the weed leaves. Overspray on crops is not a problem since Racer® is not a systemic herbicide and high leaf coverage is required for significant plant injury to occur.

Method of Manufacture and Availability:

The basic raw material for the synthesis of ammonium nonanoate is oleic acid isolated from agriculturally produced edible fats and oils. Oleic acid is exempt from EPA registration (FIFRA (25)(b)). The oleic acid content of some edible fats and oils are shown in the table below.

SOURCE	% OLEIC ACID
Butter fat	20.4
Canola oil	53.8
Corn oil	24.2
Olive oil	72.5
Sunflower oil	19.5
Soybean oil	22.3
Tallow (animal fat)	36.0

J.A.Kent, ed., *Riegel's Handbook of Industrial Chemistry, Ninth Edition*, pg. 278, 1992

Natural-based products, including oleic acid, have been isolated for over 150 years from both animal and vegetable fats in Cincinnati, Ohio by Emery Oleochemicals, a wholly owned subsidiary of PTT Oleochemicals of Selangor, Malaysia. All of the oleic acid sources shown in the table are renewable with endless U.S. supplies. The principal by-product of oleic acid production is glycerin, another FIFRA (25)(b) substance.

At the same site, Emery Oleochemicals operates a large nonanoic acid plant using oleic acid as the only starting material. In this plant, oxygen from the air is blown through oleic acid. Just as in nature, the result is a 50/50 mixture of nonanoic acid and azelaic acid, another substance widely distributed in nature. The two are separated by distillation. The isolated nonanoic acid is a water-insoluble liquid while azelaic acid is a solid material used in cosmetics, skin treatments (FDA approved), polymers, hydraulic fluids and lubricants. There is no environmental impact of this process. The plant can be expanded if needed, an expansion that would create new jobs in Ohio.

The final soap product, ammonium nonanoate, is made in a method called neutralization by mixing the oleic acid-derived nonanoic acid with ammonia dissolved in water until a clear one-phase solution with a pH range of 7 to occurs. At this point all of the nonanoic acid is converted to soap; none remains in the product. There are no by-products and no purification is required. The mixing can be done in any stirred vessel at room temperature (no heating or cooling). The final concentration depends on the amount of water used. No inert other than water is present. There is no environmental impact. Ammonia dissolved in water can be obtained from many sources, for example, from nitrogen from air and hydrogen generated by electrolysis of water. The electricity can be obtained from hydropower or wind generation. Countries that produce ammonia from hydropower now are Egypt, Peru, and Zimbabwe. For information on wind see http://www.agrinews.com/nitrogen/source/could/become/as/close/as/the/nearest/wind/turbine/story-1060.html

Petitioner's Appeal

On the basis of the data included in this petition, the petitioners believe that all food crops, whether organic or conventional, contain traces of ammonium salts of not only fatty acids, but the many other naturally occurring acids, of which there are many. Thus, ammonium nonanoate is on or in all non-processed foods and is organic.

The herbicides now acceptable with restrictions under the NOP are not part of the food chain as are fatty acids and are clearly inadequate to satisfy those organic farmers that are unable to control weeds using the NOP weed control methods. The purpose of the NOSB is to modify the NOP as new data is acquired. The many years of academic and USDA testing for new, more effective herbicides for organic farming have not been rewarding. (See comments in Exhibit E). All essential oils have been tested and found wanting. The synthesis and use of a naturally occurring substance like ammonium nonanoate are consistent with the NOP, the goals of organic farming and the beliefs of the organic consumer. Therefore, we respectfully request that the NOSB, after studying the Exhibits included with this petition, conclude that ammonium nonanoate should be added to the NOP as an allowed synthetic herbicide for weed control around food crops. We believe that it will be beneficial to the entire organic community, both growers and consumers.

Bibliography

Exhibit	Title
A.	*Atmospheric Ammonia: Source and Fate*, NOAA Aeronomy Laboratory, June 2000
B.	*NONANOIC ACID*, Peer Reviewed Literature, Feb. 2003

C. EPA *Reregistration Eligibility Document* (RED) Soap Salts, Sept. 1992

D. 2007 *Organic Herbicide Trial*, Univ. of California Cooperative Extension, Monterey County

E. *AgAlert*, pg. 9-10, California Farm Bureau, Feb. 2009

F. *Racer Efficacy Study-Bixby*, Oklahoma State University, Fall 2007

G. *Natural Herbicide Weed Control*, University of Delaware, July 2008

H. *2008 Herbicide Weed Control*, Dept. of Crop and Soil Science, The Pennsylvania State University

I. *An Efficacy Trial of Potential Herbicides for Use in Organic Systems*, North Dakota State University, May 2008

J. *Ammonium Pelargonate as a Potential Organic Herbicide*, USDA Agricultural Research Service, Lane, OK, 2008

K. *Acetic Acid*, US Department of Labor (2007) & National Institute for Occupational Safety and Health (2005).

L. *Biopesticide Registration Action Document*, Ammonium Nonanaote (PC code 031802) U.S. EPA, 2006

M. *Federal Register*, Vol. 73, No. 132, July 9, 2008

N. EPA Label, Racer® Concentrate Non-Selective Herbicide

O. Racer® Concentrate MSDS

P. *California Accepted Registration Label*, Racer® Concentrate May 2009

Q. *Florida Pesticide Registration Forms*, Racer® Concentrate Accepted August 2007

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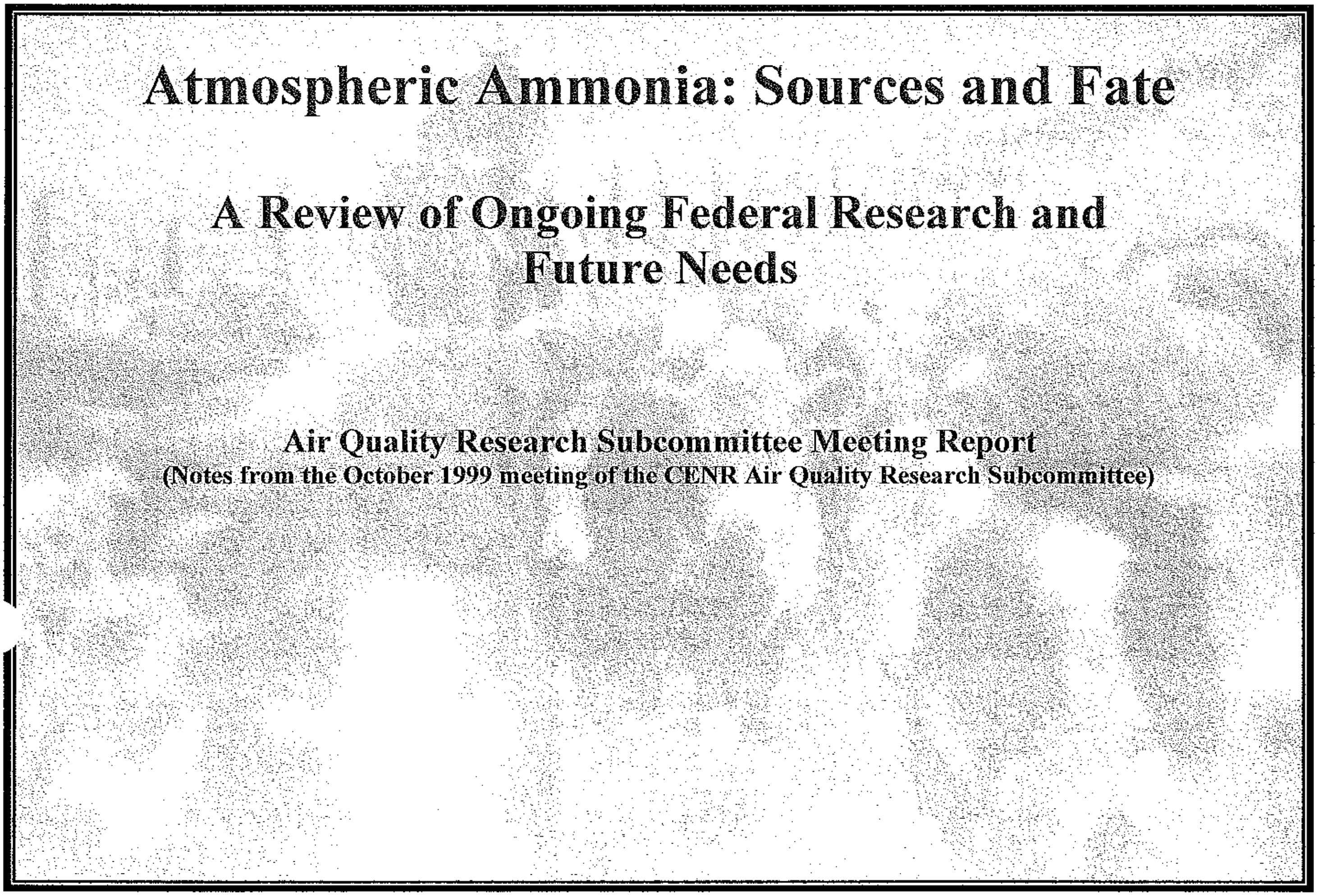
EXHIBIT A



Atmospheric Ammonia: Sources and Fate

A Review of Ongoing Federal Research and Future Needs

Air Quality Research Subcommittee Meeting Report

(Notes from the October 1999 meeting of the CENR Air Quality Research Subcommittee)

Prepared by

COMMITTEE ON THE ENVIRONMENT AND NATURAL RESOURCES
AIR QUALITY RESEARCH SUBCOMMITTEE
June 2000

Atmospheric Ammonia: Sources and Fate
A Review of Ongoing Federal Research and Future Needs

June 2000

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Atmospheric Ammonia: Sources and Fate

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INTRODUCTION

Gaseous ammonia has long been known to play a key role in atmospheric chemical processes and, following deposition, in the biogeochemical processes that occur in sensitive ecosystems (forests, soils, streams, and coastal waters). Ammonia also reacts rapidly with atmospherically-formed sulfuric and nitric acids to contribute to ambient levels of fine particles. The need to better understand the role of this important air pollutant has been underscored in recent years as ammonia emissions from intensive animal production facilities are on the increase and the Nation works to craft effective management strategies for fine particles in an effort to mitigate concerns over public health impacts and to enhance visibility in pristine areas of the country.

The October, 1999 meeting of the Air Quality Research Subcommittee of the CENR focused on a discussion of Federal research related to atmospheric ammonia. This report provides a brief summary of the current state of science as discussed at the meeting, with the addition of some material that was not presented at the meeting due to time constraints. A list of research needs resulting from this discussion is also provided. The presentation materials used by the various speakers and some additional supporting material is provided in the Appendices to this report.

A complete and comprehensive review of the science related to atmospheric ammonia is clearly beyond the scope of this report. Rather, the report provides a brief overview of the science, identifying key knowledge and capability gaps, and is intended as an information piece to guide the development of future Federal research programs.

Emissions

Current estimates of ammonia emissions to the atmosphere are characterized by a high degree of uncertainty. Agriculture represents the largest source of ammonia emissions. The diverse nature of agricultural operations and the fact that there are only a limited number of studies designed to quantify emission and activity factors in this sector have contributed to this uncertainty.

In a recent report[1] (EPA National Air Pollution Trends Update, 1970-1997) the U.S. EPA provides an estimate of the distribution of ammonia emissions by sector for the year 1997. The data are presented in Figure 1. Based on these estimates, the agricultural sector contributes approximately 85% of U.S. ammonia emissions.

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[1] EPA National Air Pollution Emissions Trends Update, 1970-1997 (1998) (http://www.epa.gov/ttnchie1/trends97/infochief.html)

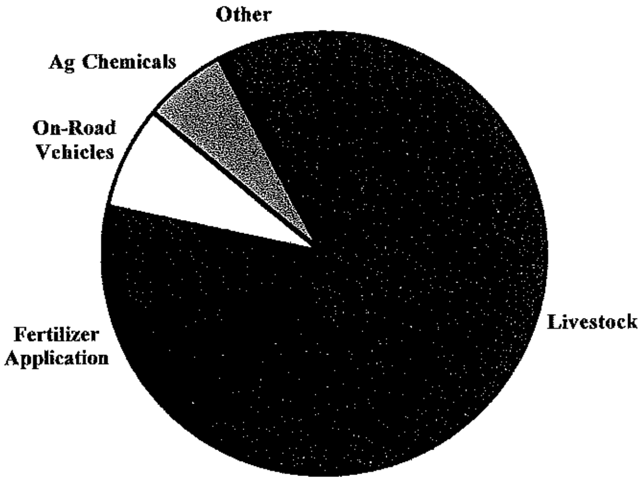

Figure 1. Total annual U.S. emissions of ammonia by sector. EPA National Air Pollution Emissions Trends Update, 1970-1997 (1998)[1]

The importance of agriculture as a contributor to the Nation's ammonia emission inventory is also evident in the emission density map for 1997 provided below. States with extensive animal-rearing operations (cattle, hogs, and poultry) are among those with the highest emission densities.

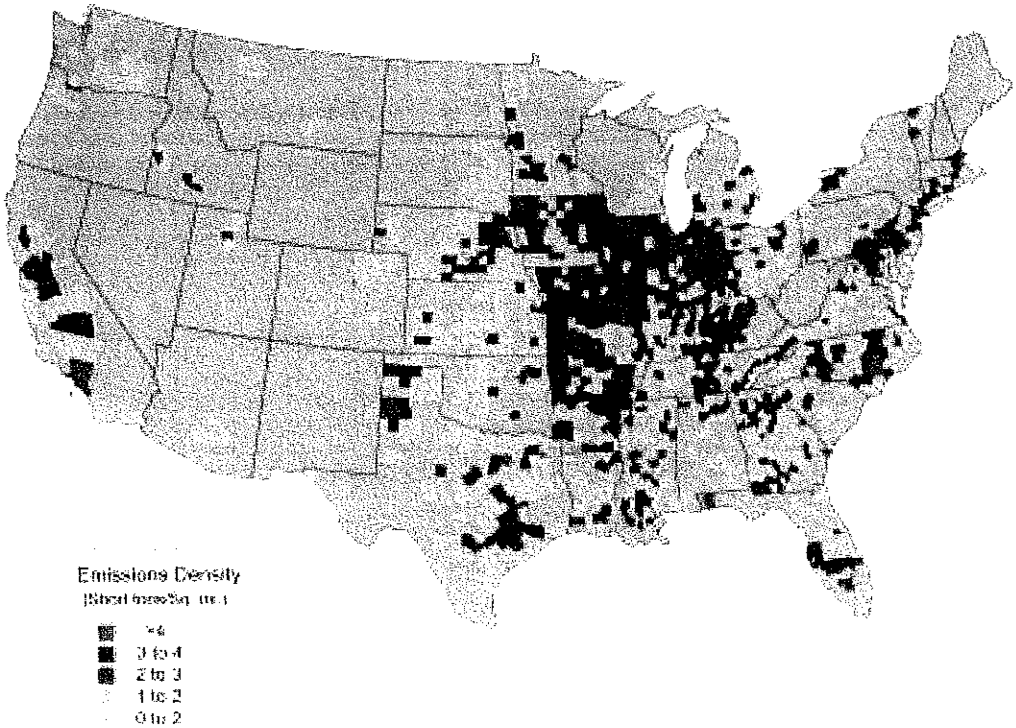

Figure 2. Map of 1997 U.S. ammonia emission density, by county. EPA National Air Pollution Emission Trends Update, 1970-1997 (1998)

Agricultural Emissions:

Ammonia emissions from agricultural operations present three major environmental issues:

- Odor – Ammonia has a strong and unpleasant odor, resulting in complaints from residents adjacent to large-scale animal rearing operations.
- Habitability – Ammonia at high levels is toxic to animals (including humans). Therefore, control of ambient ammonia levels in breeding facilities is a priority.
- Air Quality – The role of ammonia in the production of fine particles and the deposition of biological available nitrogen is the focus of this report.

During the meeting, Henry Tyrrell (USDA) gave an overview of the major agricultural sources of ammonia, which result primarily from intensive animal husbandry operations such as dairy operations and rearing facilities for beef cattle, hogs and poultry. Only about 10% of the nitrogen in feed for beef cattle is converted to meat; the rest is excreted in animals feces (~30% N) and urine (~60% N). Dairy cattle are somewhat more efficient, but about 35% of total N is still lost via the urine. In these operations, ammonia is produced when urea that is present in the urine is mixed with the urease enzyme, primarily in the feces. The N in urine is particularly volatile, and much of it ends up in the atmosphere, although 90% of the nitrogen in lagoon-stored manure also volatilizes. The amounts of ammonia emitted become highly daunting when agricultural statistics are taken into account. In 1998, there were approximately 34 million beef cattle, 9 million dairy cows, 60 million pigs, 7.6 million sheep and lambs, and over 400 million chickens being raised for meat, milk, eggs, etc. Even these large numbers are dwarfed by broiler chickens – 7.6 billion last year. This number of animals produces substantial ammonia emissions – about 10,000 metric tons NH_3/day.

James Ferguson (University of Pennsylvania) discussed potential adjustments to livestock production practices to reduce NH_3 from dairy operations. Reducing feed protein can reduce production of urea, which is all converted to NH_3. Other approaches include reducing conversion of urea to NH_3 by inhibiting urease and inhibiting volatilization of NH_3 by acidifying until land application. The particular type of enclosure developed for the University of Pennsylvania's experimental dairy cattle herd is, however, a very open one that encourages complete release of gases produced therein.

Susan Thorneloe and Larry Jones (EPA) discussed EPA research to quantify ammonia emissions from agricultural operations. Sampling campaigns have been conducted at a large hog farm using an open-path Fourier transform infrared (OP/ FTIR) spectrometer to measure NH_3 from several sources. An initial series focused on the seasonal variability of emissions from the finishing barns. Measuring across the exhaust fans has yielded estimates of these emission rates. Very limited data exist in the literature for emissions from swine finishing barns. Van Der Hoek[2] presents an emission factor used by the

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[2] Van Der Hoek, K., Estimating ammonia emission factors in Europe: summary of the work of the UNECE ammonia expert panel, Atmospheric Environment, vol. 32, pp. 315-316, 1998.

European Community (EC) as 2.89 kg/hog/yr (7.9 g/hog/day). Extending the EPA data to a similar yearly value by averaging the seasonal data suggests an emission factor of 3.69 kg/hog/yr, with an individual seasonal range of 2.74 - 4.75 kg/hog/yr. A difference of less than 25% is noted between the two emission factors. The EPA estimates may present an upper bound to the emission factor. The data have been collected during daylight, and one would expect that waste production would be reduced at night, so the integrated daily emission factor should be less. The much higher path-average concentration noted when westerly winds bring the plume from the nursery and farrowing barns through the path suggests that these sources also need to be examined. Van Der Hoek[2] used an emission factor three times higher for sows in these facilities. A detailed concentration mapping around the farm conducted during the winter season suggests that the finishing barns have 6 times the emissions of the farrowing operations because of the much larger number of animals in the finishing barns. The data from the lagoon reflect a low winter emission as reported by other researchers.

The impact of the barns locally and regionally may be affected by the thermal buoyancy of their plumes. With a 15-20°C differential between the barn plume and the ambient winter temperature, a condensation-defined plume could be visibly traced rising quickly above the 20-30 m tree canopy and, thus, moving off-site. In the summer, EPA measurements indicated little buoyant plume rise when no temperature difference existed between the barns and the ambient. One would expect that ecological interactions on or near the farm site would be more likely because the plume remains near the ground.

An analysis of the EPA data suggests that the bulk of the ammonia emissions from the swine operations comes from the barns (50%) with lesser amounts coming from lagoons (37%) and the spray application of animal waste (13%).

Pierce and Bender[3] have recently presented estimates of U.S. ammonia emissions from livestock operations. Their calculations were based on USDA agricultural statistics[4] and emission factors from Batteye et al.[5] These data (Table 1) indicate that cattle represent the largest single source of livestock emissions, with hogs a distant second.

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[3] Pierce, T.E., and L.W. Bender, Examining the temporal variability of ammonia and nitrogen oxide emissions from agricultural processes, presented at AWMA/EPA Emissions Inventory Conference, Raleigh, North Carolina, October 27, 1999. (http://www.epa.gov/asmdnerl/awma_ei99.pdf)

[4] USDA Agricultural Statistics. (http://www.nass,usda.gov/census/)

[5] Battye, R., W. Battye, C. Overcash, and S. Fudge, Development and selection of ammonia emission factors. (http://www.epa.gov/ttn/chief/efdocs/ammonia.pdf)

Table 1. Estimates of annual ammonia emissions from livestock for 1997. (Pierce and Bender, 1999)

Category	Census ($x 10^6$)	Emission Factor Kg NH_3/animal	Total Emission $x 10^6$ kg NH_3
cows	99.0	22.9	2267
hogs	61.2	9.2	563
layers-pullets	367.0	0.18	66
broilers	1037.2	0.18	187
turkeys	104.3	0.86	90
sheep	7.8	3.4	27
Total			**3200**

Ammonia Emissions From On-Road Vehicles:

Ninety five percent of U.S. automobiles are equipped with 3-way catalysts for control of nitrogen oxide pollutants. These catalysts operate by constantly oscillating the air-to-fuel ratio in the engine between oxidation and reducing conditions to simultaneously control hydrocarbon, carbon monoxide (CO), and nitrogen oxides (NO_x) emissions. Under reducing conditions, the catalyst may also produce ammonia. The EPA has instituted a limited study of the dynamics of ammonia formation by instrumenting an automobile and driving it on-road to determine ammonia as a function of operating modes. EPA is particularly interested in ammonia formation during computer commanded fuel enrichment, and is still investigating instrumentation that can give real-time output. To date they have done some limited static testing and a few on road measurements.

Measurements have been made with the instrumented vehicle in park, in the parking lot, using H_2SO_4 bubblers and a continuous chemiluminescence analyzer. The results indicated emission concentrations ranging from 5 to 55 ppm. Based on these results, on-road measurements were made over a 24-mile trip using the H_2SO_4 bubblers. The on-road measurements indicated an average emission rate of 0.24 gm/mile and would imply that ammonia emissions are in the range of NO_x emissions. Additional information on ammonia emissions from individual vehicles is provided in Table 2 and in a recent paper by Becker et al.[6]

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[6] Becker, K.H., J.C. Lorzer, R. Kurtenbach, P.Wiesen, T.E. Jensen, and T.J. Wallington, Nitrous oxide (N_2O) emissions from vehicles, Environmental Science and Technology, **33**, 4134-4139, 1999.

Table 2. Ammonia emissions from catalyst-equipped vehicles.

Data Source	Ammonia Emissions) (gm./mi
EPA Trends Report	0.1
1981 Buick	0-0.2
1983 OMS Average	0-0.5
1984 Volkswagen	0-0.14
1993 Chevrolet Lumina	
Parking Lot	0.03-0.14
Route I-40	0.24

Measurements made inside roadway tunnels provide another source of data on ammonia emissions from on-road vehicles. These studies are statistically quite robust since the measurements are representative of the thousands of vehicles that pass through the tunnel during the periods of measurement. Two such studies are discussed below.

In 1993, Fraser and Cass[7] measured ammonia levels in the Van Nuys tunnel in Los Angeles during the morning rush hour. These authors estimated ammonia emissions from dual bed and three-way catalyst-equipped vehicles in on-road operation to be 72 mg km^{-1}(0.12 g mi^{-1}) or 480 mg L^{-1}. When combined with fuel usage data for the South Coast Air Basin, the emission estimates translated into a total of 24 tons day^{-1} of ammonia for on-road vehicles. This represents approximately 13 percent of the total ammonia emissions for the region surrounding Los Angeles.

In 1999, Kean et al.[8] used measurements from the Caldecott Tunnel in the San Francisco Bay area to estimate emissions of NO_x, CO, and ammonia for a fleet of primarily gasoline-powered light-duty vehicles. These authors reported the ammonia emissions from this fleet to be 475±29 mg L^{-1}. This result is in excellent agreement with the previous estimate of Fraser and Cass.

It is important to note that, during the period between these two studies, the State of California instituted regulations to reduce the sulfur content of auto fuel. Sulfur in gasoline is known to poison the three-way catalysts that are used in cars and light duty trucks. The California regulations were designed to improve NO_x-removal efficiency in an effort to reduce ozone and fine particle levels. As EPA has moved to reduce the sulfur content of gasoline nationally, concern has been raised that improved catalyst performance might result in an increase in ammonia emissions from on-road vehicles. The similarity of the ammonia emission factors obtained for fleets with very different

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[7] Fraser, M.P., and G.R. Cass, Detection of excess ammonia emissions from in-use vehicles and the implications for fine particle control, Environmental Science and Technology, 32, 1053-1057, 1998.

[8] Kean, A.J., R.A. Harley, R.F. Sawyer, D. Littlejohn, D. Zucker, and G.R. Kendall, On-road measurement of ammonia and other motor vehicle exhaust emissions, presented at the 10th CRC On-Road Vehicle Emissions Workshop, San Diego, California, March 27-29, 2000.

fuel sulfur levels (more than an order of magnitude) argues against an adverse impact on ammonia emissions.

Ammonia "Slip" in Power Plants:

Nitrogen oxide control technology for power plants is another area where there has been concern that an emission management strategy that targets one pollutant (NO_x) may have the unintended effect of increasing emissions of another pollutant (ammonia). The level of NO_x control that EPA is calling for from power plants to reduce ozone levels in the eastern U.S will require the use of Selective Catalytic Reduction (SCR) and Selective Non-Catalytic Reduction (SNCR) systems. Both of these technologies require the addition of ammonia as part of the NO_x-control process.

Tom Feeley (Department of Energy) evaluated the significance of ammonia emissions resulting from the application of SCR and SNCR technologies in response to the 22-state NO_x SIP call. DOE's "worst case" analysis concluded that the application of these NO_x-control technologies would result in 5100-8700 tons yr^{-1} additional ammonia emissions in the 22-state region. These emissions would represent approximately one quarter of one percent of current U.S. ammonia emissions.

ATMOSPHERIC CHEMISTRY

Fred Fehsenfeld (NOAA) discussed the role of ammonia as a major contributor to secondary aerosol formation in the atmosphere. Ammonia reacts rapidly with both sulfuric and nitric acids to form fine particles.

$$NH_3 + H_2SO_4 \Rightarrow NH_4HSO_4 + NH_3 \Rightarrow (NH_4)_2SO_4$$

$$NH_3 + HNO_3 \Leftrightarrow NH_4NO_3$$

Reaction of ammonia with sulfuric acid or ammonium bisulfate is favored over reaction with nitric acid. Thus, in most of the U.S. the majority of aerosol ammonium is associated with sulfate ion. However, significant amounts of ammonium nitrate are formed in regions where sulfate levels are low and ammonia and nitrogen oxide emissions are high (e.g., Southern California and the Mountain West). The ammonium nitrate formed is thermally unstable and in dynamic equilibrium with ammonia and nitric acid. Since sulfate aerosols deposit much more slowly than either ammonia or nitric acid, the formation of ammonium sulfate aerosol serves to distribute the ammonia/ammonium over a much larger region than occurs when nitrate aerosol is formed.

Results from recent laboratory and field studies[9] suggest that ammonia actually promotes the nucleation of sulfuric acid in the atmosphere. This effect is not well understood and results in rates of particle nucleation in the atmosphere that appear to be much faster than expected based on current theory.

DEPOSITION

Once released into the atmosphere, ammonia is returned to the surface as either gaseous ammonia or as an ammonium ion. The ammonium ion can be associated with nitrate, sulfate, or some other anion and incorporated into an aerosol or as part of the ionic mix found in cloud and raindrops.

The deposition of ammonia gas is an extremely complex process. The analysis of data collected during studies of ammonia transport and deposition[10,11]suggests that atmospheric ammonia is in dynamic equilibrium with growing vegetation. There apparently is a "compensation point" related to the partial pressure of ammonia in leaf tissue of plants. The surface is a sink for ammonia when the ambient concentration exceeds the compensation point. The surface is a source when ambient levels are below the compensation point. The absorption/desorption of ammonia from vegetation and soils is not included in most air quality models, which certainly contributes to the uncertainty in estimates of ammonia/ammonium transport and deposition.

Estimates of dry deposition of ammonium ion can be obtained from the aerosol deposition estimates produced by EPA's Clean Air Status and Trends Network (CASTNet) and NOAA's Atmospheric Integrated Research Monitoring Network (AIRMoN) networks. Ammonia deposition estimates are obtained as weekly averages.

Ammonium deposited in precipitation is quantified as part of the interagency National Atmospheric Deposition Program/National Trends Network (NADP/NTN). Ammonium ion concentration in precipitation throughout the U.S. is shown in Figure 3. The spatial distribution is strikingly similar to the ammonia emissions distribution shown in Figure 1, suggesting that local ammonia sources have a significant impact on broad regional patterns of ammonium wet deposition.

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[9] Weber, R.J., P.H. McMurry, R.L. Mauldin, D.J. Tanner, F.L. Eisele, A.D. Clarke, and V.N. Kapustin, New particle formation in the remote troposphere – A comparison at various sites, Geophysical Research Letters, **26**, 307-310, 1999.

[10] Galbally, I.E., G.D. Farquhar, and G.P. Ayers, in: Cycling of Carbon, Nitrogen, Sulfur, and Phosphorous in Terresterial and Aquatic Ecosystems, J.R. Freney and I.E. Galbally, Eds. (Springer-Verlag, Berlin) pp. 1-9, 1982.

[11] Langford, A.O., and F.C. Fehsenfeld, Natural vegetation as a source or sink for atmospheric ammonia: A case study, Science, **255**, 581-583, 1992.

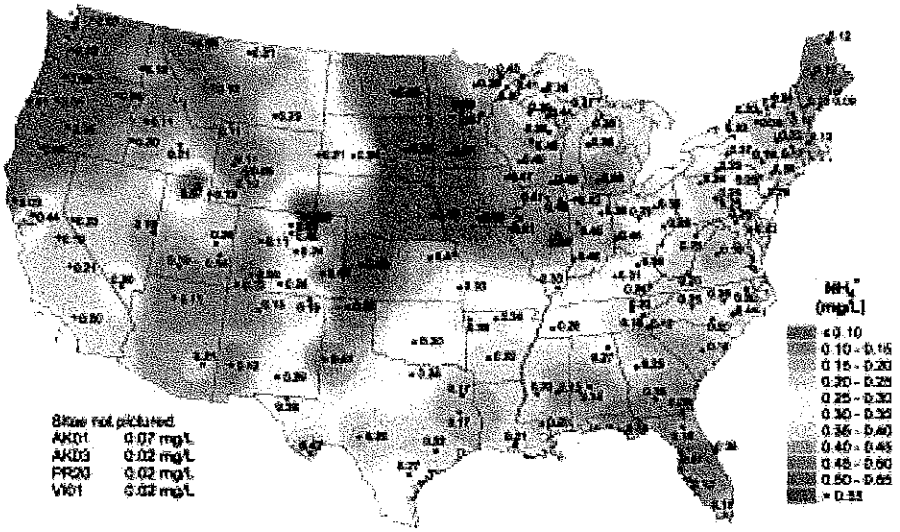

Figure 3. Ammonium ion concentration in precipitation for 1998. National Atmospheric Deposition Program/National Trends Network[12]

A modified Seasonal Kendall analysis of trends in ammonium in precipitation is shown in Figure 4. The effect of trends in precipitation volume was removed prior to the non-parametric test for trends in ammonium concentration. Approximately 23% of the sites had statistically significant ($\alpha < 0.05/n$) increasing trends, mostly in the Southeast and West. Decreasing trends were observed at less than 1% of the sites.

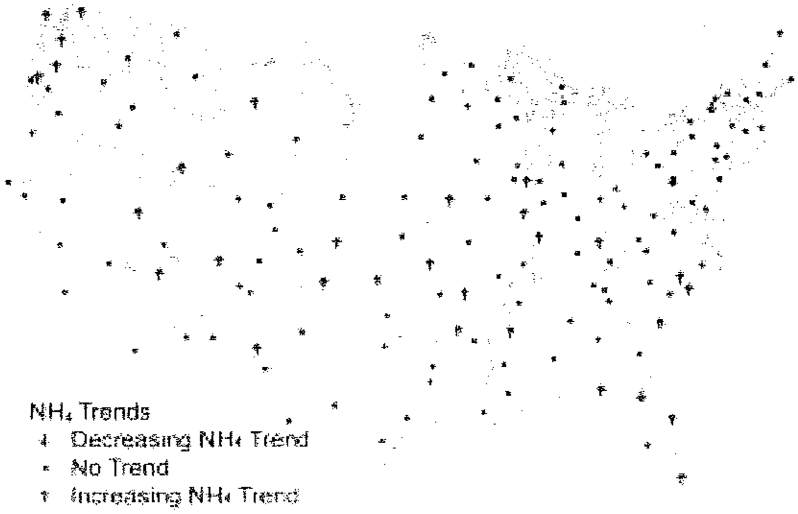

Figure 4. Trends in ammonium concentration in precipitation for the period 1981-1997. (USGS, Mark Nilles, private communication)

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[12] NADP/NTN (http://nadp.sws.uiuc.edu)

MEASUREMENT

The accurate quantification of atmospheric ammonia is particularly challenging, primarily for two reasons. Firstly, ammonia is a sticky gas that readily adsorbs onto almost all surfaces. Much of the adsorbed material will subsequently desorb if ammonia levels decrease in the sample air stream. Thus, contact surfaces in inlets, samplers, and analytical systems can cause both positive and negative artifacts in the measurement of ammonia. Secondly, the human body produces its own ammonia emissions, which provides an opportunity for measurement/sample contamination.

A variety of techniques have been used to measure ambient ammonia. Integrated samples have been collected with passive samplers, sulfuric acid bubblers and citric acid coated filters and denuders. Chemiluminescence NO_x monitors will respond to ammonia when a molybdenum catalyst in the inlet is operated at high temperature. Ambient ammonia concentration can then be determined by differencing scrubbed and unscrubbed sampling streams.

Two promising new techniques for the measurement of ambient ammonia are currently being evaluated. NOAA has developed a chemical ionization mass spectrometer (CIMS) that can measure sub-parts-per-billion levels with a one-second response time. NOAA has just completed an extensive comparison of their CIMS instrument with a citric acid denuder system. These two techniques agreed very well. EPA is investigating the use of ion mobility spectroscopy (IMS) for ammonia measurement. Ammonia's strong proton affinity makes it a good candidate for IMS. The IMS can sample at one-second intervals and is a good candidate for on-road measurements.

Historically, the primary methods available for determining emissions from large area sources were point-sampling techniques employing flux chambers or evacuated canisters followed by analysis of the appropriate gas samples. Remote sensing techniques are now available for quantifying emissions from large, heterogeneous area sources, such as municipal wastewater treatment facilities, waste lagoons, and surface coal mines. These techniques produce a path-integrated concentration, typically reported in units of parts per million-meter (ppm-m) of the species of interest, eliminating concern over source heterogeneity. Open-path Fourier transform infrared (OP/FTIR) spectroscopy is one of the remote sensing techniques that has received wide attention within the last decade.

The measurement of the ammonium content of ambient aerosols has traditionally utilized integrated filter collection followed by laboratory analysis of the filter extract. In recent years, new techniques have been developed for the semi-continuous (5-15 min) speciation (including ammonium) of bulk atmospheric aerosols. A comparison of several of these techniques was conducted as part of the recent Atlanta PM "SuperSite" study with encouraging results (Figure 5)[13].

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[13] Rodney Weber, Georgia Institute of Technology, private communication.

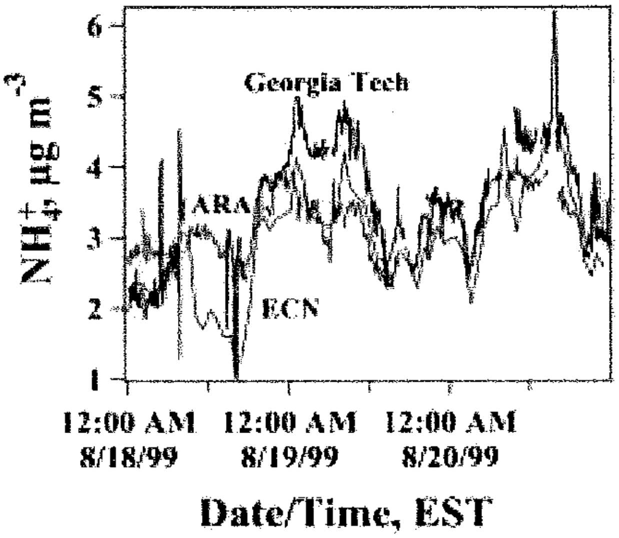

Figure 5. Aerosol ammonium time series from three semi-continuous aerosol speciation monitors. Data collected in Atlanta during the 1999 PM "SuperSite" experiment. ARA (Atmospheric Research Associates), ECN (Netherlands Energy Research Foundation)

In addition, several single-particle mass spectrometer systems are now operational that are capable of characterizing the composition of individual particles. These fast-response aerosol speciation systems are revolutionizing the measurement of particle-phase ammonium, and promise to provide insights into the chemistry of atmospheric ammonia/ammonium and source/receptor relationships that were not previously possible.

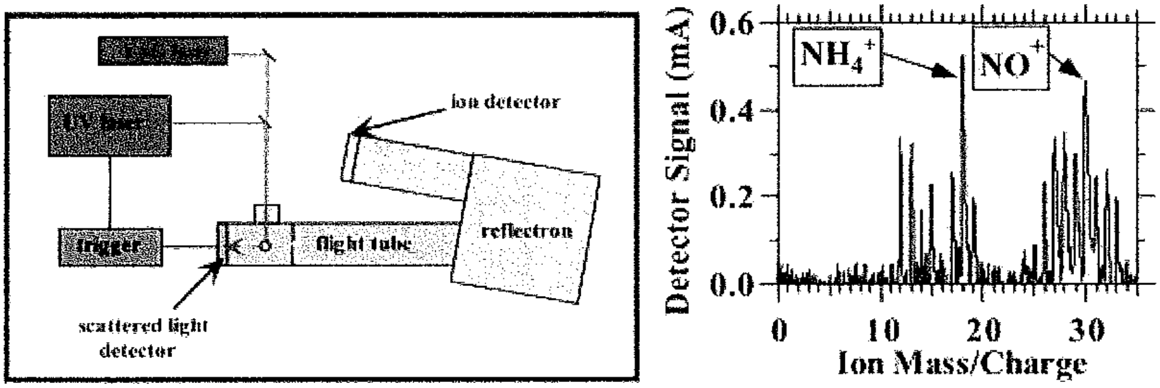

Figure 6. NOAA's Particle Analysis by Laser Mass Spectrometer (PALMS) single particle mass spectrometer with a mass spectra of a ammonium particle.

Precipitation chemistry samples are integrated over a two-week period at the vast majority of NADP/NTN sites. A limited number of the Atmospheric Integrated Research Monitoring Network (AIRMoN) sites (part of NADP/NTN) perform event sampling. The ammonium concentrations in samples from the former sites can be compromised by biological activity in the sample containers. This effect is significantly reduced at the event sites, since the samples spend a shorter time in the field containers and the samples are either refrigerated or preservatives are added to minimize biological activity.

RESEARCH NEEDS

This report provides a broad overview of what is known about atmospheric ammonia and its impact on local and regional air quality. Clearly, a great deal is already known and research programs are in place that promise a clearer understanding in the next few years. However, in an effort to insure that all the key information gaps are being addressed and that opportunities for interagency collaboration are identified, it is instructive to list the research needs that were identified by the Air Quality Research Subcommittee.

Emissions

The U.S ammonia emissions inventory is highly uncertain. An accurate assessment of emissions is the first step in the development of a successful management strategy. Therefore, improving the quality of the emissions inventory must be a high priority, with emphasis on the agricultural sector, which is clearly the largest contributor. Specifically, research is needed on:

- Emission factors for existing livestock operations.
- Impact of agricultural practices on ammonia mitigation.
- Ammonia emissions from light-duty vehicles as a function of operating condition and fuel type.
- Simultaneous on-road measurement of ammonia, NO_x, and CO emissions via remote sensing is recommended to determine the distribution and inter-relationship of emissions across individual vehicles and model years.
- Natural emissions.

Atmospheric Chemistry and Transport

Ammonia plays a key role in the formation and composition of fine particles, and the processes involved are not well understood. The ammonia/ammonium interchange has a significant impact on the distribution and deposition of ammonia and its conversion products. Specifically, research is needed on:

- The role of ammonia in particle nucleation.
- The interchange of ammonia/ammonium with vegetation, soils, and water bodies.
- The status of ammonium/sulfate neutralization, particularly in the eastern U.S., and the potential for ammonium nitrate formation.

Deposition

Ammonium is deposited as either gaseous ammonia, aerosol ammonium, or ammonium ion in cloud droplets and precipitation. The deposition of ammonium in precipitation is well characterized; less is known about the dry deposition of ammonia/ammonium. Specifically, research is needed on:

- Deposition/emission of ammonia to/from a wide range of surfaces under different meteorological conditions.
- Deposition of aerosol ammonium. An improved quantification of aerosol ammonium deposition rates and distribution is needed.
- Source/receptor relationships, including apportionment of ambient ammonia and deposited ammonium to source categories and source regions.

Measurement

A wide variety of traditional and some exciting new techniques are being used to quantify gaseous ammonia and aerosol ammonium concentrations in the atmosphere. To date, only limited comparisons have been conducted. Specifically, research is needed on:

- New, fast response, and highly sensitive techniques for the measurement of ammonia/ammonium.
- Comparability of data from techniques being employed to measure ammonia/ammonium.
- Procedures to mitigate the impact of biological processes on the measurement of ammonium in precipitation.

Models

Computer models are important tools in the management of air quality. In this application, they are a bridge between science and policy and should represent the current state of knowledge. Many of the atmospheric processes critical to an accurate description of ammonia transformation, transport, and deposition are not adequately described in current air quality models. Specifically, research is needed on:

- Numerical methods that accurately characterize the formation of ammonium-containing aerosols, including their size distribution and optical properties.
- Model representations to account for the complex atmosphere/surface exchange processes involving ammonia.
- Evaluated buoyant plume rise schemes appropriate to the dispersion of ammonia from animal-rearing facilities.

APPENDIX A – MEETING AGENDA

CENR

AIR QUALITY RESEARCH SUBCOMMITTEE

October 15, 1999

AGENDA

Continuation of discussions on the integration of atmospheric and health-related research on PM

1:00 – 1:30

- Status of the PM research working group - Dan Albritton (NOAA)

Ammonia – emissions, transport, transformation fate and effects

1:30 – 2:15

- Overview of ammonia emissions from agricultural sources – Henry Tyrrell (USDA, CSREES)
- Nitrogen transport through a modern dairy production system - James Ferguson (Univ. of Pennsylvania)

2:15 – 2:35

- Ammonia "slip" – Thomas Feeley (DOE-FETC)

2:35 – 2:55

- Ammonia emission inventories – Jim Vickery (EPA)

2:55 – 3:15

- Ammonia transport, transformation, deposition, and measurement – Fred Fehsenfeld (NOAA)

3:15 –3:45

- Ammonia deposition – Bruce Hicks (NOAA) and Mark Nilles (USGS)

General business

3:45 – 4:00

Dan Albritton will discuss future topics for the Subcommittee.

APPENDIX B – SELECTED REFERENCES

Langford, A.O., and F.C. Fehsenfeld, Natural vegetation as a source or sink for atmospheric ammonia: A case study, Science, 255, 581-583, 1992

Fraser, M.P., and G.R. Cass, Detection of excess ammonia emissions from in-use vehicles and the implications for fine particle control, Environmental Science and Technology, 32, 1053-1057, 1998.

Atmospheric Environment Volume 32, No. 3 pp. 269 – 590, 1998. This special issue of the journal includes selected papers from an International Conference on Ammonia that was held in Culham, Oxford, 2-4 October 1995.

Becker, K.H., J.C. Lorzer, R. Kurtenbach, P.Wiesen, T.E. Jensen, and T.J. Wallington, Nitrous oxide (N_2O) emissions from vehicles, Environmental Science and Technology, 33, 4134-4139, 1999.

Kean, A.J., R.A. Harley, R.F. Sawyer, D. Littlejohn, D. Zucker, and G.R. Kendall, On-road measurement of ammonia and other motor vehicle exhaust emissions, to be presented at the 10th CRC On-Road Vehicle Emissions Workshop, San Diego, California, March 27-29, 2000.

EXHIBIT B

NONANOIC ACID

CASRN: 112-05-0

For other data, click on the Table of Contents

Human Health Effects:

Human Toxicity Excerpts:

A 12% SOLN OF NONANOIC ACID IN PETROLATUM PRODUCED NO IRRITATION ON HUMAN SKIN AFTER A 48-HR CLOSED PATCH TEST. ... NO SENSITIZATION REACTIONS WERE PRODUCED IN 25 VOLUNTEERS AFTER PATCH TESTING WITH NONANOIC ACID (12% IN PETROLATUM).
[Clayton, G.D., F.E. Clayton (eds.) Patty's Industrial Hygiene and Toxicology. Volumes 2A, 2B, 2C, 2D, 2E, 2F: Toxicology. 4th ed. New York, NY: John Wiley & Sons Inc., 1993-1994., p. 3559]**PEER REVIEWED**

VARIOUS CONCN OF NONANOIC ACID IN 1-PROPANOL WERE APPLIED TO 116 HEALTHY VOLUNTEERS AND 75 DERMATITIS PATIENTS AS A POSITIVE CONTROL FOR PATCH TESTING. A DOSE OF 20% PRODUCED SKIN REACTIONS IN 90.1-93.9% OF SUBJECTS. LESIONS CONSISTED OF ERYTHEMA AT 48 HR & PIGMENTATION @ 96 HR.
[WAHLBERG JE, MAIBACH HI; CONTACT DERMATITIS 6 (2): 128 (1980)]**PEER REVIEWED**

Human Toxicity Values:

LD50 Rat oral 15 g/kg
[Clayton, G.D., F.E. Clayton (eds.) Patty's Industrial Hygiene and Toxicology. Volumes 2A, 2B, 2C, 2D, 2E, 2F: Toxicology. 4th ed. New York, NY: John Wiley & Sons Inc., 1993-1994., p. 3559]**PEER REVIEWED**

Probable Routes of Human Exposure:

NIOSH (NOES Survey 1981-1983) has statistically estimated that 46,467 workers (1,484 of these are female) are potentially exposed to nonanoic acid in the US(1). Occupational exposure to nonanoic acid may occur through dermal contact with this compound at workplaces where nonanoic acid is produced or used(SRC). The general population will be exposed to nonanoic acid via inhalation of ambient air, ingestion of food and drinking water, and dermal contact with food and other products containing nonanoic acid(SRC).
[(1) NIOSH; National Occupational Exposure Survey (NOES) (1983)]**PEER REVIEWED**

Emergency Medical Treatment:

Emergency Medical Treatment:

EMT Copyright Disclaimer:

The following Overview, *** GENERAL OR UNKNOWN CHEMICAL ***, is relevant for this HSDB record chemical.

Life Support:

- o This overview assumes that basic life support measures have been instituted.

Clinical Effects:

0.2.1 SUMMARY OF EXPOSURE
 0.2.1.1 ACUTE EXPOSURE
  A) A SPECIFIC REVIEW on the clinical effects and treatment of individuals exposed to this agent HAS NOT YET BEEN PREPARED. The following pertains to the GENERAL EVALUATION and TREATMENT of individuals exposed to potentially toxic chemicals.
  B) GENERAL EVALUATION -
   1) Exposed individuals should have a careful, thorough medical history and physical examination performed, looking for any abnormalities. Exposure to chemicals with a strong odor often results in such nonspecific symptoms as headache, dizziness, weakness, and nausea.
  C) IRRITATION -
   1) Many chemicals cause irritation of the eyes, skin, and respiratory tract. In severe cases respiratory tract irritation can progress to ARDS/acute lung injury, which may be delayed in onset for up to 24 to 72 hours in some cases.
   2) Irritation or burns of the esophagus or gastrointestinal tract are also possible if caustic or irritant chemicals are ingested.
  D) HYPERSENSITIVITY -
   1) A number of chemical agents produce an allergic

hypersensitivity dermatitis or asthma with bronchospasm and wheezing with chronic exposure.

Laboratory:

A) A number of chemicals produce abnormalities of the hematopoietic system, liver, and kidneys. Monitoring complete blood count, urinalysis, and liver and kidney function tests is suggested for patients with significant exposure.

B) If respiratory tract irritation or respiratory depression is evident, monitor arterial blood gases, chest x-ray, and pulmonary function tests.

Treatment Overview:

0.4.2 ORAL EXPOSURE

- A) GASTRIC LAVAGE
  - 1) Significant esophageal or gastrointestinal tract irritation or burns may occur following ingestion. The possible benefit of early removal of some ingested material by cautious gastric lavage must be weighed against potential complications of bleeding or perforation.
  - 2) GASTRIC LAVAGE: Consider after ingestion of a potentially life-threatening amount of poison if it can be performed soon after ingestion (generally within 1 hour). Protect airway by placement in Trendelenburg and left lateral decubitus position or by endotracheal intubation. Control any seizures first.
    - a) CONTRAINDICATIONS: Loss of airway protective reflexes or decreased level of consciousness in unintubated patients; following ingestion of corrosives; hydrocarbons (high aspiration potential); patients at risk of hemorrhage or gastrointestinal perforation; and trivial or non-toxic ingestion.
- B) ACTIVATED CHARCOAL
  - 1) Activated charcoal binds most toxic agents and can decrease their systemic absorption if administered soon after ingestion. In general, metals and acids are poorly bound and patients ingesting these materials will not likely benefit from activated charcoal administration.
    - a) Activated charcoal should not be given to patients ingesting strong acidic or basic caustic chemicals. Activated charcoal is also of unproven value in patients ingesting irritant chemicals, where it may obscure endoscopic findings when the procedure is justified.
  - 2) ACTIVATED CHARCOAL: Administer charcoal as a slurry (240 mL water/30 g charcoal). Usual dose: 25 to 100 g in adults/adolescents, 25 to 50 g in children (1 to 12 years), and 1 g/kg in infants less than 1 year old.
- C) DILUTION -
  - 1) Immediate dilution with milk or water may be of benefit in caustic or irritant chemical ingestions.
  - 2) DILUTION: Immediately dilute with 4 to 8 ounces (120 to 240 mL) of water or milk (not to exceed 4 ounces/120 mL

in a child).

D) IRRITATION -
  1) Observe patients with ingestion carefully for the possible development of esophageal or gastrointestinal tract irritation or burns. If signs or symptoms of esophageal irritation or burns are present, consider endoscopy to determine the extent of injury.

E) OBSERVATION CRITERIA -
  1) Carefully observe patients with ingestion exposure for the development of any systemic signs or symptoms and administer symptomatic treatment as necessary.
  2) Patients symptomatic following exposure should be observed in a controlled setting until all signs and symptoms have fully resolved.

0.4.3 INHALATION EXPOSURE

A) DECONTAMINATION -
  1) INHALATION: Move patient to fresh air. Monitor for respiratory distress. If cough or difficulty breathing develops, evaluate for respiratory tract irritation, bronchitis, or pneumonitis. Administer oxygen and assist ventilation as required. Treat bronchospasm with inhaled beta2 agonist and oral or parenteral corticosteroids.

B) IRRITATION -
  1) Respiratory tract irritation, if severe, can progress to pulmonary edema which may be delayed in onset up to 24 to 72 hours after exposure in some cases.

C) ACUTE LUNG INJURY -
  1) ACUTE LUNG INJURY: Maintain ventilation and oxygenation and evaluate with frequent arterial blood gas or pulse oximetry monitoring. Early use of PEEP and mechanical ventilation may be needed.

D) BRONCHOSPASM -
  1) If bronchospasm and wheezing occur, consider treatment with inhaled sympathomimetic agents.

E) OBSERVATION CRITERIA -
  1) Carefully observe patients with inhalation exposure for the development of any systemic signs or symptoms and administer symptomatic treatment as necessary.
  2) Patients symptomatic following exposure should be observed in a controlled setting until all signs and symptoms have fully resolved.

0.4.4 EYE EXPOSURE

A) DECONTAMINATION: Irrigate exposed eyes with copious amounts of room temperature water for at least 15 minutes. If irritation, pain, swelling, lacrimation, or photophobia persist, the patient should be seen in a health care facility.

0.4.5 DERMAL EXPOSURE

A) OVERVIEW
  1) DERMAL DECONTAMINATION -
    a) DECONTAMINATION: Remove contaminated clothing and wash exposed area thoroughly with soap and water. A physician may need to examine the area if irritation or pain persists.
  2) PESTICIDES -

a) DECONTAMINATION: Remove contaminated clothing and jewelry. Wash the skin, including hair and nails, vigorously; do repeated soap washings. Discard contaminated clothing.

3) IRRITATION -

a) Treat dermal irritation or burns with standard topical therapy. Patients developing dermal hypersensitivity reactions may require treatment with systemic or topical corticosteroids or antihistamines.

4) DERMAL ABSORPTION -

a) Some chemicals can produce systemic poisoning by absorption through intact skin. Carefully observe patients with dermal exposure for the development of any systemic signs or symptoms and administer symptomatic treatment as necessary.

Range of Toxicity:

A) No specific range of toxicity can be established for the broad field of chemicals in general.

[Rumack BH POISINDEX(R) Information System Micromedex, Inc., Englewood, CO, 2006; CCIS Volume 130, edition expires Nov, 2006. Hall AH & Rumack BH (Eds): TOMES(R) Information System Micromedex, Inc., Englewood, CO, 2006; CCIS Volume 130, edition expires Nov, 2006., p.]**PEER REVIEWED**

Animal Toxicity Studies:

Non-Human Toxicity Excerpts:

NO SYMPTOMS OF TOXICITY COULD BE PRODUCED BY INHALATION OF CONCN VAPORS IN RATS.
[Clayton, G.D., F.E. Clayton (eds.) Patty's Industrial Hygiene and Toxicology. Volumes 2A, 2B, 2C, 2D, 2E, 2F: Toxicology. 4th ed. New York, NY: John Wiley & Sons Inc., 1993-1994., p. 3558]**PEER REVIEWED**

NONANOIC ACID, FED FOR 4 WK @ 4.17% IN DIET, DEPRESSED RATE OF GROWTH ONLY IN VITAMIN B12-DEFICIENT RATS. 5% IN DIET WAS FAIRLY WELL UTILIZED BY GROWING CHICKS.
[Clayton, G.D., F.E. Clayton (eds.) Patty's Industrial Hygiene and Toxicology. Volumes 2A, 2B, 2C, 2D, 2E, 2F: Toxicology. 4th ed. New York, NY: John Wiley & Sons Inc., 1993-1994., p. 3559]**PEER REVIEWED**

NONANOIC ACID DECR THE CONTRACTILE FORCE OF ISOMETRICALLY ACTING RAT PAPILLARY MUSCLES, WITH THE EFFECT DEPENDING ON BOTH CONCN (0.1-1 MMOL) AND TIME OF EXPOSURE (2-12 MIN). THE POSTEXTRASYSTOLIC POTENTIATION AND THE TIME TO REACH A NEW STEADY STATE LEVEL OF CONTRACTION FOLLOWING A PAIRED PULSE STIMULATION WERE INCR BY NONANOIC ACID.
[CAFFIER G, PFEIFFER C; ACTA BIOL MED GER 36 (7-8): 1077 (1977)]**PEER REVIEWED**

...(0.5 OR 1.0 MOLAR IN PROPANOL) CAUSED IRRITATION /IN HUMANS/ WHEN APPLIED UNDER OCCLUSIVE PATCHES.
[Clayton, G.D., F.E. Clayton (eds.) Patty's Industrial Hygiene and Toxicology. Volumes 2A, 2B, 2C, 2D, 2E, 2F: Toxicology. 4th ed. New York, NY: John Wiley & Sons Inc., 1993-1994., p. 3559]**PEER REVIEWED**

Non-Human Toxicity Values:

LD50 Mouse iv 224 + or - 4.6 mg/kg
[Budavari, S. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. Whitehouse Station, NJ: Merck and Co., Inc., 1996., p. 1214]**PEER REVIEWED**

TSCA Test Submissions:

Nonanoic acid (CAS # **112-05-0**) was evaluated for subchronic dermal toxicity and irritation in New Zealand White rabbits (5/sex/group) exposed to 500 mg/kg/day (25% w/w in mineral oil) for 5 days/week for 2 weeks. Half of the animals (3 males, 2 females) received applications upon abraded skin and half (3 females, 2 males) received applications on intact skin. Applications remained uncovered. An additional control group of 10 rabbits was treated dermally with 2 g/kg/day mineral oil. There were no mortalities throughout treatment or 2-week recovery (4 rabbits). All treated animals showed slight weight losses in the second week and food consumption was diminished in 2nd and 3rd weeks of study. Severe erythema, slight to severe edema characterized signs of irritation at the sites of application with necrosis and eschar appearing in all animals in the second week. Atonia, desquamation, fissuring and exfoliation of eschar tissue were noted as well. Treatment-related weight loss and signs of dermal irritation resolved in animals held for 2-week recovery. Upon necropsy of 6 animals (3/abraded and 3/intact) at 2 weeks, no treatment- related gross pathology was identified other than morphological changes of treated dermis. Microscopic examination revealed generally localized necrosis accompanied by epidermal hyperplasia, hyperkeratosis, and occasional diffuse and perifollicular dermal inflammation at both abraded and intact application sites. Treated rabbits held for recovery was reepithelialized and continuous with normal follicular structure and population, and with persisting mild to moderate epidermal hyperplasia and hyperkeratosis. Microscopic examination of select visceral organs from 6 rabbits at 2 weeks and 4 recovered rabbits at 4 weeks failed to expose a systemic effect of treatment.
[RHONE-POULENC INC; A 28-Day Dermal Toxicity Study in Rabbits; 9/30/81; EPA Doc No. 88-920010172; Fiche No. OTS0546557]**UNREVIEWED**

Nonanoic acid (CAS # **112-05-0**) was evaluated for developmental and maternal toxicity in 22 pregnant Crl:COBS, CDBR rats administered doses of 1500 mg/kg bw by oral intubation on gestational days 6 through 15. A control group of 22 female rats received gavage doses of corn oil (vehicle). On Day 20, all rats were sacrificed for Caesarian delivery and determination of fetal/embryotoxicity and teratogenic effects, as well as fertility indices and maternal toxicity. No excess mortality, retarded bodyweight gains, decreased food consumption or other clinical signs of maternal toxicity were observed relative to control. Likewise, gross pathology upon terminal sacrifice identified no treatment-related effects in the pregnant dams. Pregnancy rates, mean number of corpora

lutea, implantations, and mean implantation efficiency (implantations per corpora lutea) were comparable to controls, as were gravid and nongravid uterine weights, and mean ovarian, uterine, and litter data. Embryotoxic effects (number of resorptions, number of fetuses, fetal viability, mean fetal bodyweight, mean fetal length) were not observed. Gross pathology and skeletal examinations produced no statistically significant evidence of fetotoxicity or teratogenicity in a viable fetal population similar to that in the control group. Of 80 fetuses from 22 litters of the treated rats, there were 2 instances of cleft palate, 2 fetuses with small tongue, and a single incidence hydroureter that were not seen in control fetuses. Skeletal anomalies were likewise not statistically linked to treatment and the number of variant fetuses (2) were equal to variant controls.
[RHONE-POULENC INC; Teratology Screen in Rats, Project No. 299-534; 7/28/83; EPA Doc No. 88-920009562; Fiche No. OTS0571218]**UNREVIEWED**

Metabolism/Pharmacokinetics:

Metabolism/Metabolites:

INFUSION OF AN EMULSION CONTAINING 20% TRINONANOATE, 0.9% SODIUM CHLORIDE, & 1% SOYBEAN LECITHINS INTO DOGS RESULTED IN OXIDN OF NONANOIC ACID.
[BACH A ET AL; NUTR METAB 14 (4): 203 (1972)]**PEER REVIEWED**

NONANOIC ACID IS METABOLIZED BY THE LIVER TO PRODUCE KETONE BODIES. METABOLISM OCCURS VIA BETA-OXIDATION, AND NO EVIDENCE WAS FOUND IN RATS OF CHAIN ELONGATION OR TISSUE STORAGE OF THE ACID. METAB OF THE TERMINAL PROPIONIC ACID RESIDUE RESULTS IN INCREASED GLUCOSE AND GLYCOGEN SYNTHESIS.
[Clayton, G.D., F.E. Clayton (eds.) Patty's Industrial Hygiene and Toxicology. Volumes 2A, 2B, 2C, 2D, 2E, 2F: Toxicology. 4th ed. New York, NY: John Wiley & Sons Inc., 1993-1994., p. 3560]**PEER REVIEWED**

Pharmacology:

Environmental Fate & Exposure:

Environmental Fate/Exposure Summary:

Nonanoic acid may be released into the environment in various waste streams from its production and use in organic syntheses, lacquers, plastics, in the production of hydrotropic salts, pharmaceuticals, synthetic flavors and odors, esters for turbojet lubricants, as a flotation agent, vinyl plasticizer, and as a gasoline additive. If released to the atmosphere, nonanoic acid is expected to exist solely as a vapor in the ambient atmosphere based on a measured vapor pressure of 1.6X10-3 mm Hg. Vapor-phase nonanoic acid will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals with an estimated half-life of 1.6 days. If released to soil, nonanoic acid is expected to have low mobility based on an estimated Koc of 1700. Volatilization of nonanoic acid from dry soil surfaces is not expected to occur based on its measured vapor pressure. An estimated Henry's Law constant of 1.6X10-6 atm-cu m/mole indicates that volatilization from wet soil surfaces may be important. Limited biodegradation data suggest that nonanoic acid has the potential to biodegrade in both soil and water under aerobic conditions. If released into water, nonanoic acid is expected to adsorb to suspended solids and sediment in the water column based on its estimated Koc. Nonanoic acid's pKa of 4.95 indicates that it will exist predominately in the ionized form at environmental pHs. Volatilization of nonanoic acid from water surfaces is not expected to be an important fate process based on this compound's pKa and its estimated Henry's Law constant. The potential for bioconcentration of nonanoic acid in aquatic organisms is high based on an estimated BCF of 230. Hydrolysis is not expected to be an important process due to the lack of hydrolyzable functional groups. Occupational exposure to nonanoic acid may occur through dermal contact with this compound at workplaces where nonanoic acid is produced or used. The general population will be exposed to nonanoic acid via inhalation of ambient air, ingestion of food and drinking water, and dermal contact with food and other products containing nonanoic acid. (SRC) **PEER REVIEWED**

Probable Routes of Human Exposure:

NIOSH (NOES Survey 1981-1983) has statistically estimated that 46,467 workers (1,484 of these are female) are potentially exposed to nonanoic acid in the US(1). Occupational exposure to nonanoic acid may occur through dermal contact with this compound at workplaces where nonanoic acid is produced or used(SRC). The general population will be exposed to nonanoic acid via inhalation of ambient air, ingestion of food and drinking water, and dermal contact with food and other products containing nonanoic acid(SRC).
[(1) NIOSH; National Occupational Exposure Survey (NOES) (1983)]**PEER REVIEWED**

Natural Pollution Sources:

...AS AN ESTER IN OIL OF PELARGONIUM.
[The Merck Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976., p. 916]**PEER REVIEWED**

...IN SEVERAL ESSENTIAL OILS, EITHER FREE OR ESTERIFIED: ROSE, GERANIUM, ORRIS, LITSEA CUBEBA, ARTEMISIA ARBORESCENS L, HOPS, CHAMAECYPARIS PISIFERA ENDL, EREMOCITRUS GLAUCA L, FRENCH LAVENDER, AND IN OAK MUSK.
[Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975., p. 433]**PEER REVIEWED**

Nonanoic acid was identified as a volatile constituent of the kiwi fruit flower(1).
[(1) Tatsuka K et al; J Agric Food Chem 38: 2176-80 (1993)]**PEER REVIEWED**

Artificial Pollution Sources:

Nonanoic acid's production and use in organic syntheses, lacquers, plastics, in the production of hydrotropic salts, pharmaceuticals, synthetic flavors and odors, esters for turbojet lubricants, as a flotation agent, vinyl plasticizer, and as a gasoline additive(1) may result in its release to the environment through various waste streams(SRC).
[(1) Lewis RJ Jr; Hawley's Condensed Chemical Dictionary 12th ed NY, NY: Van Nostrand Reinhold Co p. 877 (1993)]**QC REVIEWED**

Environmental Fate:

TERRESTRIAL FATE: Based on a recommended classification scheme(1), an estimated Koc value of 1700(SRC), determined from a measured log Kow of 3.42(2) and a recommended regression-derived equation(3), indicates that nonanoic acid is expected to have low mobility in soil(SRC). Volatilization of nonanoic acid may be important from moist soil surfaces(SRC) given an estimated Henry's Law constant of 1.6X10-6 atm-cu m/mole(SRC) from its experimental values for vapor pressure, 1.6X10-3 mm Hg(4), and water solubility, 210 mg/l(5). Nonanoic acid is not expected to volatilize from dry soil surfaces based on its measured vapor pressure(4). Biodegradation of nonanoic acid in studies using sewage and sludge inoculum(6,7) indicate that biodegradation in soil may be important(SRC).
[(1) Swann RL et al; Res Rev 85: 23 (1983) (2) Sangster J; LOGKOW Databank, Sangster Res Lab, Montreal Quebec, Canada (1994) (3) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington DC: Amer Chem Soc pp. 4-9 (1990) (4) Daubert TE, Danner RP; Physical and thermodynamic properties of pure chemicals: data compilation. Design Inst Phys Prop Data, Amer Inst Chem Eng., Washington, DC: Taylor & Francis, Vol 4 (1995) (5) Yalkowsky SH, Dannenfelser RM; Aquasol Database of Aqueous Solubility. Ver 5. College of Pharmacy, Univ of Ariz - Tucson, AZ. PC Ver (1992) (6) Yonezawa Y et al; Kogai Shigen Kenkyusho Iho 12: 85-91 (1982) (7) Heukelekian H, Rand MC; J Water Pollut Contr Assoc 27: 1040-53 (1955)]**PEER REVIEWED**

AQUATIC FATE: Based on a recommended classification scheme(1), an estimated Koc value of 1700(SRC), determined from a measured log Kow of 3.42(2) and a recommended regression-derived equation(3), indicates that nonanoic acid is expected to adsorb to suspended solids and sediment in water(SRC). Nonanoic acid may volatilize from water surfaces(3,SRC) based on an estimated Henry's Law constant of 1.6X10-6 atm-cu m/mole(SRC) from its experimental values for vapor pressure, 1.6X10-3 mm Hg(4), and water solubility, 210 mg/l(5). Estimated volatilization half-lives for a model river and model lake are 29 and 210 days, respectively(3,SRC). Nonanoic acid's pKa of 4.95 at 25 deg C(6) indicates that nonanoic acid will exist predominately in the ionized form under environmental pHs(SRC). Volatilization of the ionized form from water surfaces is not expected to be an important fate process(SRC). According to a classification scheme(7), an estimated BCF value of 230(3,SRC), from a measured log Kow(2), suggests that bioconcentration in aquatic organisms is high(SRC). A total organic carbon removal ratio of 99% was observed for nonanoic acid using a non-acclimated activated sludge and an initial nonanoic acid concn of 100 mg total organic carbon/l(8). A BOD of 0.59 (g/g) was observed for nonanoic acid after 5 days incubation using a sewage inoculum(9).
[(1) Swann RL et al; Res Rev 85: 23 (1983) (2) Sangster J; LOGKOW

Databank, Sangster Res Lab, Montreal Quebec, Canada (1994) (3) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington DC: Amer Chem Soc pp. 4-9, 5-4, 5-10, 15-1 to 15-29 (1990) (4) Daubert TE, Danner RP; Physical and thermodynamic properties of pure chemicals: data compilation. Design Inst Phys Prop Data, Amer Inst Chem Eng., Washington, DC: Taylor & Francis, Vol 4 (1995) (5) Yalkowsky SH, Dannenfelser RM; Aquasol Database of Aqueous Solubility. Version 5. College of Pharmacy, Univ of Ariz - Tucson, AZ. PC Version. (1992) (6) Dean JA; Handbook of Organic Chemistry, NY, NY: McGraw-Hill, Inc p. 8-45 (1987) (7) Franke C et al; Chemosphere 29: 1501-14 (1994) (8) Yonezawa Y et al; Kogai Shigen Kenkyusho Iho 12: 85-91 (1982) (9) Heukelekian H, Rand MC; J Water Pollut Contr Assoc 27: 1040-53 (1955)]**PEER REVIEWED**

ATMOSPHERIC FATE: According to a model of gas/particle partitioning of semivolatile organic compounds in the atmosphere(1), nonanoic acid, which has a measured vapor pressure of 1.6X10-3 mm Hg at 25 deg C(2), is expected to exist solely as a vapor in the ambient atmosphere. Vapor-phase nonanoic acid is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals(SRC); the half-life for this reaction in air is estimated to be about 1.6 days(3,SRC).
[(1) Bidleman TF; Environ Sci Technol 22: 361-367 (1988) (2) Daubert TE, Danner RP; Physical and thermodynamic properties of pure chemicals: data compilation. Design Inst Phys Prop Data, Amer Inst Chem Eng., Washington, DC: Taylor & Francis, Vol 4 (1995) (3) Meylan WM, Howard PH; Chemosphere 26: 2293-99 (1993)]**PEER REVIEWED**

Environmental Biodegradation:

A total organic carbon removal ratio of 99% was observed for nonanoic acid using a non-acclimated activated sludge and an initial nonanoic acid concn of 100 mg total organic carbon/l(1). A BOD of 0.59 (g/g) was observed for nonanoic acid after 5 days incubation using a sewage inoculum(2). A 75% decrease in the initial nonanoic acid concn of 1.6 mg/l was observed after 21 days incubation in an aerobic mixed bacterial culture obtained from trench leachate at a low-level radioactive waste disposal site in West Valley, NY(3). An increase of 52% in the nonanoic acid concn of 4.2 mg/l in anaerobic bacterial cultures obtained from trench leachate was attributed to the breakdown of complex compounds(3).
[(1) Yonezawa Y et al; Kogai Shigen Kenkyusho Iho 12: 85-91 (1982) (2) Heukelekian H, Rand MC; J Water Pollut Contr Assoc 27: 1040-53 (1955) (3) Francis AJ; Environmental Migration of Long-lived Radionuclides, Vienna, Austria: Inter Atomic Energy Agency IAEA-SM-257/72 pp. 415-29 (1982)]**PEER REVIEWED**

Environmental Abiotic Degradation:

The rate constant for the vapor-phase reaction of nonanoic acid with photochemically-produced hydroxyl radicals has been estimated as 9.8X10-12 cu cm/molecule-sec at 25 deg C(SRC) using a structure estimation method(1,SRC). This corresponds to an atmospheric half-life of about 1.6 days at an atmospheric concn of 5X10+5 hydroxyl radicals per cu cm(1,SRC). Nonanoic acid is not expected to undergo hydrolysis in the environment(SRC) due to the lack of functional groups to hydrolyze(2).

[(1) Meylan WM, Howard PH; Chemosphere 26: 2293-99 (1993) (2) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington DC: Amer Chem Soc pp. 7-4, 7-5 (1990)]**PEER REVIEWED**

Environmental Bioconcentration:

An estimated BCF value of 230 was calculated for nonanoic acid(SRC), using a measured log Kow of 3.42(1) and a recommended regression-derived equation(2). According to a classification scheme(3), this BCF value suggests that bioconcentration in aquatic organisms is high(SRC).
[(1) Sangster J; LOGKOW Databank, Sangster Res Lab, Montreal Quebec, Canada (1994) (2) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington DC: Amer Chem Soc pp. 5-4, 5-10 (1990) (3) Franke C et al; Chemosphere 29: 1501-14 (1994)]**PEER REVIEWED**

Soil Adsorption/Mobility:

The Koc of nonanoic acid is estimated as approximately 1700(SRC), using a measured log Kow of 3.42(1) and a regression-derived equation(2,SRC). According to a recommended classification scheme(3), this estimated Koc value suggests that nonanoic acid is expected to have low mobility in soil(SRC).
[(1) Sangster J; LOGKOW Databank, Sangster Res Lab, Montreal Quebec, Canada (1994) (2) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington DC: Amer Chem Soc pp. 4-9 (1990) (3) Swann RL et al; Res Rev 85: 23 (1983)]**PEER REVIEWED**

Volatilization from Water/Soil:

The Henry's Law constant for nonanoic acid is estimated as 1.6X10-6 atm-cu m/mole(SRC) from its experimental values for vapor pressure, 1.6X10-3 mm Hg(1), and water solubility, 210 mg/l(2). This value indicates that nonanoic acid will volatilize slowly from water surfaces(3,SRC). Based on this Henry's Law constant, the estimated volatilization half-life from a model river (1 m deep, flowing 1 m/sec, wind velocity of 3 m/sec) is estimated as approximately 29 days(3,SRC). The estimated volatilization half-life from a model lake (1 m deep, flowing 0.05 m/sec, wind velocity of 0.5 m/sec) is estimated as approximately 210 days(3,SRC). Nonanoic acid's pKa of 4.95 at 25 deg C(4) indicates that nonanoic acid will exist predominately in the ionized form under environmental pHs(SRC). Volatilization of the ionized form from water surfaces is not expected to be an important fate process(SRC). Nonanoic acid's Henry's Law constant(1,2,SRC) indicates that volatilization from moist soil surfaces may occur(SRC). Nonanoic acid is not expected to volatilize from dry soil surfaces(SRC) based on a measured vapor pressure of 1.6X10-3 mm Hg(1).
[(1) Daubert TE, Danner RP; Physical and thermodynamic properties of pure chemicals: data compilation. Design Inst Phys Prop Data, Amer Inst Chem Eng., Washington, DC: Taylor & Francis, Vol 4 (1995) (2) Yalkowsky SH, Dannenfelser RM; Aquasol Database of Aqueous Solubility. Version 5. College of Pharmacy, Univ of Ariz - Tucson, AZ. PC Version. (1992) (3) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington DC: Amer Chem Soc pp. 15-1 to 15-29 (1990) (4) Dean JA;

Handbook of Organic Chemistry, NY,NY: McGraw-Hill, Inc p. 8-45 (1987)]**PEER REVIEWED**

Environmental Water Concentrations:

DRINKING WATER: Nonanoic acid was quantitatively detected in drinking water in: Cincinnati, OH in Oct 1978; New Orleans, LA in Jan 1976; Philadelphia, PA in Feb 1976; Ottumwa, IA in Sept 1976; and Seattle, WA in Nov 1976(1). Nonanoic acid was detected in treated water samples taken from sampling taps in treatment works at an unspecified concn(2).
[(1) Lucas SV; GC/MS Analysis of Organics in Drinking Water Concentrates and Advanced Waste Treatment Concentrates: Vol 1 Analysis Results for 17 Drinking Water, 16 Advanced Waste Treatment and 3 Process Blank Concentrates USEPA-600/1-84-020A (NTIS PB85-128221) Columbus, OH: Columbus Labs Health Eff Res Lab (1984) (2) Fielding M et al; Organic Micropollutants in Drinking Water, TR-159, Medmenham, Eng Water Res Cent (1981)]**PEER REVIEWED**

SURFACE WATER: Nonanoic acid was detected at a concn of 0.01 ppb in a water sample from the Inner Harbor Navigation Canal, Lake Pontchartain, New Orleans, LA collected at a depth of 10 m on the flood tide on June 23, 1980(1).
[(1) McFall AJ et al; Chemosphere 14: 1253-65 (1985)]**PEER REVIEWED**

RAIN/SNOW: Nonanoic acid was detected in rainwater samples collected in a suburb of Hannover, Germany at an unspecified concn(1). Rain and snow samples collected from nine different locations in southern CA between 1982 and 1984 contained nonanoic acid at concns ranging from 0.007 to 0.14 uM(2). Rainwater samples collected in west Los Angeles between 1982 and 1983 contained nonanoic acid at concns ranging from 0.01 to 0.13 uM(2).
[(1) Winkeler HD et al; Vom Wasser 70: 107-17 (1988) (2) Kawamura K et al; Atmos Environ 30: 1035-52 (1996)]**PEER REVIEWED**

Effluent Concentrations:

Nonanoic acid was detected in aqueous industrial effluent extracts collected between Nov 1979-81 in the following industrial categories (concentration in one effluent extract): ore mining (12 ng/ul); auto and other laundries (34 ng/ul); porcelain/enameling (28 ng/ul); electronics (3084 ng/ul); mechanical products (1954 ng/ul); and publicly owned treatment works at an unknown concn(1). Nonanoic acid was identified in the acidic fraction of sewage and sludge from the Iona Island Sewage Treatment Plant, British Columbia(2). The acidic fraction of oil shale retort water from the Kerosene Creek seam of the Rundle deposit, Queensland, Australia, was found to contain nonanoic acid at a concn of 200 mg/l(3). A grab sample, obtained in April 1980, of the final effluent from the Addison, IL Publicly Owned Treatment Works was found to contain nonanoic acid at an unreported concn(4). Groundwater samples contaminated by industrial pollution near Barcelona, Spain were found to contain nonanoic acid at concns ranging from <5 to 75 ng/l(5). Nonanoic acid was detected in trench leachate from a low-level radioactive waste disposal site in West Valley, NY at an average concn of 4.5 mg/l(6). Nonanoic acid was detected in process retort water from the Occidental Oil Shale, Inc facility in Logan

Wash, CO at a concn of 81 mg/l(7).
[(1) Bursey JT, Pellizzari ED; Analysis of Industrial Wastewater for Organic Pollutants in Consent Degree Survey, Contract No. 68-03-2867, Athens, GA: USEPA Environ Res Lab (1982) (2) Rogers IH et al; Water Pollut Res J Canada 21: 187-204 (1986) (3) Dobson KR et al; Water Res J 19: 849-56 (1985) (4) Ellis DD et al; Arch Environ Contam Toxicol 11: 373-82 (1982) (5) Guardiola J et al; Water Supply 7: 11-16 (1989) (6) Francis AJ et al; Nuclear Tech 50: 158-63 (1980) (7) Leenheer JA et al; Environ Sci Technol 16: 714-23 (1982)]**PEER REVIEWED**

Nonanoic acid was detected in: process water from in situ coal gasification in Gillette, WY at a concn of 5 ppm; retort water from in situ oil shale processing in Rock Springs, WY at a concn of 493 ppm; and boiler blowdown water from in situ shale oil processing in DeBeque, CO at a concn of 132 ppm(1). Nonanoic acid was identified as a byproduct of chlorine dioxide disinfection of drinking water at a pilot plant in Evansville, IN(2). Fine aerosol emission rates of nonanoic acid from heavy-duty diesel trucks, noncatalyst-equipped, and catalyst-equipped automobiles were 146.9, 8.6, and 196.2 ug/km, respectively(3). Nonanoic acid was detected in road dust particles collected from paved streets in a residential area of Pasadena, CA in May 1988 at a concn of 135.4 ug/g of particle sample; brake lining particles at a concn of 87.4 ug/g of particle sample; and tire wear particles at a concn of 90.9 ug/g of particle sample(4). Nonanoic acid was identified as a fine particle released from a natural gas-fired space heater and water heater; emission rates were 225.2 pg/kJ and 482.6 pg/kJ for the first series of filters and backup filters within the samplers, respectively(5).
[(1) Pellizzari ED et al; Identification of organic components in aqueous effluents from energy-related processes. ASTM Spec Tech Publ. STP 686 pp. 256-73 (1979) (2) Richardson SD et al; Environ Sci Technol 28: 592-99 (1994) (3) Rogge WF et al; Environ Sci Technol 27: 636-51 (1993) (4) Rogge WF et al; Environ Sci Technol 27: 1892-904 (1993) (5) Rogge WF et al; Environ Sci Technol 27: 2736-44 (1993)]**PEER REVIEWED**

Sediment/Soil Concentrations:

Nonanoic acid was detected but not quantitated in sediment samples collected from Dokai Bay, Japan on Sept 28 1990(1).
[(1) Terashi A et al; Bull Environ Contam Toxicol 50: 348-55 (1993)]**PEER REVIEWED**

Atmospheric Concentrations:

Nonanoic acid was identified in air samples collected along the Niagara River in Sept 1982 at an unreported concn(1). The average ambient annual concn of nonanoic acid in fine particles collected from West Los Angeles, downtown Los Angeles, Pasadena, Rubidoux, and San Nicolas Island, CA in 1982 was 3.3, 6.6, 5.3, 9.9, and 0.24 ng/cu m, respectively(2). Nonanoic acid was detected in emissions from a municipal waste incineration plant at an unspecified concn(3). Nonanoic acid was detected at an unreported concn in forest air samples collected in a spruce forest in Eggegebirge, North-Rhine Westphalia(4). Air samples collected in Los Angeles between July and Sept 1984

contained 0.0009 to 0.011 ppb nonanoic acid(5). Nonanoic acid was detected in exhaust from a gasoline engine at a concn of 0.052 ppb(5). Remote aerosol samples collected from the North Pacific Ocean, heavily vegetated areas of American Samoa, and the Marshall Islands contained a nonanoic acid concn of 0.031, 4.91, and 0.060 mg/cu m, respectively(6).
[(1) Hoff RM, Chan K; Environ Sci Technol 21: 556-61 (1987) (2) Rogge WF et al; Atmos Environ 27A: 1309-30 (1993) (3) Jay K, Stieglitz L; Chemosphere 30: 1249-60 (1995) (4) Helmig D et al; Chemosphere 19: 1399-1412 (1989) (5) Kawamura K et al; Environ Sci Technol 19: 1082-6 (1985) (6) Kawamura K, Gagosian RB; Nature 325: 330-1 (1987)]**PEER REVIEWED**

Food Survey Values:

Nonanoic acid was identified as a volatile component of raw beef(1). Nonanoic acid has been identified as a volatile flavor component of mutton and beef(2). Aerosol emission rates of nonanoic acid from frying hamburger meat was 10.2 mg/kg of meat cooked; emission rates from charbroiling hamburger was 30.6 mg/kg of meat cooked for extra lean hamburger (approx. 10.0% fat) and 47.1 mg/kg of meat cooked for regular hamburger (approx. 21% fat)(3).
[(1) King MF et al; J Agric Food Chem 41: 1974-81 (1993) (2) Shahidi F et al; CRC Crit Rev Food Sci Nature 24: 141-243 (1986) (3) Rogge WF et al; Environ Sci Technol 25: 1112-25 (1991)]**PEER REVIEWED**

Plant Concentrations:

Nonanoic acid was identified as a volatile constituent of the kiwi fruit flower(1). Nonanoic acid was found in fine particulate matter released (by resuspension and agitation of the leaf composites) from green and dead plant leaves at concns of 444.7 and 596.8 ug/g, respectively(2).
[(1) Tatsuka K et al; J Agric Food Chem 38: 2176-80 (1993) (2) Rogge WF et al; Environ Sci Technol 27: 2700-11 (1993)]**PEER REVIEWED**

Fish/Seafood Concentrations:

Nonanoic acid was detected in fresh mussels obtained from the Oarai Coast in Ibaraki, Japan at a concn of 0.08 ug/g wet weight(1).
[(1) Yashuara A; J Chromatogr; 409: 251-8 (1987)]**PEER REVIEWED**

Other Environmental Concentrations:

Dust samples collected from 12 households in three urban areas of central Finland contained nonanoic acid at an unreported concn(1).
[(1) Hirvonen A et al; Indoor Air 4: 255-64 (1994)]**PEER REVIEWED**

Environmental Standards & Regulations:

FDA Requirements:

Nonanoic acid is a food additive permitted for direct addition to food for human consumption as a synthetic flavoring substance and adjuvant in accordance with the following conditions: 1) the quantity added to food does not exceed the amount reasonably required to accomplish its intended physical, nutritive, or other technical effect in food, and 2) when intended for use in or on food it is of appropriate food grade and is prepared and handled as a food ingredient.
[21 CFR 172.515 (4/1/96)]**PEER REVIEWED**

Chemical/Physical Properties:

Molecular Formula:

C9-H18-O2
PEER REVIEWED

Molecular Weight:

158.24
[Budavari, S. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. Whitehouse Station, NJ: Merck and Co., Inc., 1996., p. 1214]**PEER REVIEWED**

Color/Form:

COLORLESS, OILY LIQUID @ ORDINARY TEMP; CRYSTALLIZES WHEN COOLED
[Budavari, S. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. Whitehouse Station, NJ: Merck and Co., Inc., 1996., p. 1214]**PEER REVIEWED**

YELLOWISH OIL
[Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 12th ed. New York, NY: Van Nostrand Rheinhold Co., 1993, p. 877]**PEER REVIEWED**

Odor:

FATTY ODOR
[Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975., p. 433]**PEER REVIEWED**

COCONUT AROMA
[Furia, T.E. (ed.). CRC Handbook of Food Additives. 2nd ed. Volume 2. Boca Raton, Florida: CRC Press, Inc., 1980., p. 293]**PEER REVIEWED**

Slight odor
[Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 12th ed. New York, NY: Van Nostrand Rheinhold Co., 1993, p. 877]**PEER REVIEWED**

Taste:

UNPLEASANT TASTE
[Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975., p. 433]**PEER REVIEWED**

EXCELLENT COCONUT TASTE
[Furia, T.E. (ed.). CRC Handbook of Food Additives. 2nd ed. Volume 2. Boca Raton, Florida: CRC Press, Inc., 1980., p. 293]**PEER REVIEWED**

Boiling Point:

252-253 DEG C @ 760 MM HG
[Budavari, S. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. Whitehouse Station, NJ: Merck and Co., Inc., 1996., p. 1214]**PEER REVIEWED**

Melting Point:

12.5 DEG C
[Budavari, S. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. Whitehouse Station, NJ: Merck and Co., Inc., 1996., p. 1214]**PEER REVIEWED**

Density/Specific Gravity:

0.9052 g/cu cm at 20 deg C
[Lide, D.R. (ed.). CRC Handbook of Chemistry and Physics. 76th ed. Boca Raton, FL: CRC Press Inc., 1995-1996., p. 3-224]**PEER REVIEWED**

Dissociation Constants:

pKa = 4.95 at 25 deg C
[Dean, J.A. Handbook of Organic Chemistry. New York, NY: McGraw-Hill Book Co., 1987., p. 8-45]**PEER REVIEWED**

Heat of Combustion:

-5,456.1 kJ/mol
[Kirk-Othmer Encyclopedia of Chemical Technology. 4th ed. Volumes 1: New York, NY. John Wiley and Sons, 1991-Present., p. V5 149]**PEER REVIEWED**

Octanol/Water Partition Coefficient:

Log Kow = 3.42
[Sangster J; LOGKOW Databank, Sangster Res Lab, Montreal Quebec, Canada (1994)]**PEER REVIEWED**

Solubilities:

Soluble in alcohol, chloroform, ether
[Budavari, S. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. Whitehouse Station, NJ: Merck and Co., Inc., 1996., p. 1214]**PEER REVIEWED**

1:8 IN 50% ALCOHOL; 1:3 IN 60% ALCOHOL; INSOL IN WATER; SOL IN MOST ORG SOLVENTS
[Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975., p. 433]**PEER REVIEWED**

In water, 2.12X10+2 mg/l at 30 deg C.
[Yalkowsky SH, Dannenfelser RM; Aquasol Database of Aqueous Solubility. Version 5. College of Pharmacy, Univ of Ariz - Tucson, AZ. PC Version (1992)]**PEER REVIEWED**

Spectral Properties:

INDEX OF REFRACTION: 1.4330 @ 20 DEG C/D
[Budavari, S. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. Whitehouse Station, NJ: Merck and Co., Inc., 1996., p. 1214]**PEER REVIEWED**

IR: 60 (Sadtler Research Laboratories Prism Collection)
[Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985., p. V2 4]**PEER REVIEWED**

NMR: 9 (Sadtler Research Laboratories Spectral Collection)
[Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985., p. V2 4]**PEER REVIEWED**

MASS: 988 (Atlas of Mass Spectral Data, John Wiley & Sons, New York)
[Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985., p. V2 4]**PEER REVIEWED**

Vapor Pressure:

1.65X10-3 mm Hg at 25 deg C /From experimentally derived coefficients/
[Daubert, T.E., R.P. Danner. Physical and Thermodynamic Properties of Pure Chemicals Data Compilation. Washington, D.C.: Taylor and Francis, 1989., p.]**PEER REVIEWED**

Viscosity:

8.08 mPa sec at 20 deg C
[Kirk-Othmer Encyclopedia of Chemical Technology. 4th ed. Volumes 1:

New York, NY. John Wiley and Sons, 1991-Present., p. V5 149]**PEER REVIEWED**

Other Chemical/Physical Properties:

Boiling point = 255.6 deg C
[Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 12th ed. New York, NY: Van Nostrand Rheinhold Co., 1993, p. 877]**PEER REVIEWED**

Acid value: 351 mg KOH/g
[Ashford, R.D. Ashford's Dictionary of Industrial Chemicals. London, England: Wavelength Publications Ltd., 1994., p. 665]**PEER REVIEWED**

Specific heat: 2.91 J/g (for the solid); Heat of fusion: 20.3 kJ/mol.
[Kirk-Othmer Encyclopedia of Chemical Technology. 4th ed. Volumes 1: New York, NY. John Wiley and Sons, 1991-Present., p. V5 149]**PEER REVIEWED**

Chemical Safety & Handling:

Hazardous Decomposition:

When heated to decomposition it emits acrid smoke and irritating fumes.
[Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 2498]**PEER REVIEWED**

Occupational Exposure Standards:

Manufacturing/Use Information:

Major Uses:

Organic synthesis, lacquers, plastics, production of hydrotropic salts, pharmaceuticals, synthetic flavors and odors, flotation agent, esters for turbojet lubricants, vinyl plasticizer, gasoline additive.
[Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 12th ed. New York, NY: Van Nostrand Rheinhold Co., 1993, p. 877]**PEER REVIEWED**

CHEM INT FOR NONANOYL CHLORIDE
PEER REVIEWED

CHEM INT FOR SPECIALTY DIESTERS-EG, WITH PROPYLENE GLYCOL
PEER REVIEWED

Manufacturers:

Henkel Corporation, Hq, The Triad, Suite 200, 2200 Renaissance Boulevard, Gulph Mills, PA 19406, (610) 270-8100; The Emery Group, 11501 Northlake Drive, P.O. Box 429557, Cincinnati, OH 45249 (513) 482-3000; Production site: 4900 Este Avenue, Cincinnati, OH 45202.
[SRI. 1996 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1996., p. 592]**PEER REVIEWED**

Hoescht Celanese Corp, Hq, Route 202-206 North, P.O. Box 2500, Somerville, NJ 08876, (908) 231-2000; Chemical Group; Commodity Chemicals, 1601 West LBJ Freeway, P.O. Box 819005, Dallas, TX, (214) 277-4000; Production site: P.O. Box 509, Bay City, TX 77414.
[SRI. 1996 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1996., p. 592]**PEER REVIEWED**

Methods of Manufacturing:

Prepn from unsaturated hydrocarbons by the oxo process: Hill, U.S. pat 2,815,355 (1957 to Standard Oil of Indiana); from tall oil unsaturated fatty acids: Maggiolo, U.S. pat 2,865,937 (1958 to Welsbach); by oxidation of oleic acid: Mackenzie, Morgan, U.S. pat 2,820,046 (1958 to Celanese); from rice bran oil fatty acid: Mihara et al, U.S. pat 3,060211 (1962 to Toya Koatsu Ind). Purification: Port, Reiser, U.S. pat 2,890,230 (1959 to U.S.D.A.).
[Budavari, S. (ed.). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. Whitehouse Station, NJ: Merck and Co., Inc., 1996., p. 1214]**PEER REVIEWED**

BY OXIDN OF METHYLNONYL KETONE; FROM HEPTYL IODIDE VIA MALONIC ESTER SYNTHESIS.
[Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975., p. 433]**PEER REVIEWED**

By oxidation of nonyl alcohol or nonyl aldehyde, the oxidation of oleic acid, especially by ozone.
[Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 12th ed. New York, NY: Van Nostrand Rheinhold Co., 1993, p. 877]**PEER REVIEWED**

General Manufacturing Information:

NON-ALCOHOLIC BEVERAGES 1.8 PPM; ICE CREAM, ICES, ETC 7.8 PPM; CANDY 6.6 PPM; BAKED GOODS 13 PPM; SHORTENING 10 PPM.
[Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975., p. 433]**PEER REVIEWED**

FLAVORS USEFUL IN COCONUT, BERRY.
[Furia, T.E. (ed.). CRC Handbook of Food Additives. 2nd ed. Volume 2. Boca Raton, Florida: CRC Press, Inc., 1980., p. 293]**PEER REVIEWED**

PELARGONIC ACID SHOWED STRONG ANTIBACTERIAL ACTIVITY AGAINST STREPTOCOCCUS FAECALIS IN SILKWORM LARVAE.
[IIZUKA T ET AL; J FAC AGRIC, HOKKAIDO UNIV 59 (2): 262 (1979)]**PEER REVIEWED**

PELARGONIC ACID INHIBITED CLEAVAGE OF HEMICENTROTUS PULCHERRIMUS EGGS AT A CONCN OF 200 PPM.
[IWANAMI Y ET AL; CELL STRUCT FUNCT 4 (1): 67 (1979)]**PEER REVIEWED**

PELARGONIC ACID INHIBITED POLLEN GERMINATION (AVG GERMINATION 0-1.1%) AND POLLEN TUBE ELONGATION (AVG TUBE LENGTH 0-0.2 NM) IN CAMELLIA SINENSIS AND MITOTIC DIVISION OF GENERATIVE NUCLEUS IN ORNITHOGALUM VIRENS (AVG MITOSIS 0-40.6%).
[IWANAMI Y, IWADARE T; BOT GAZ (CHICAGO) 140 (1): 1 (1979)]**PEER REVIEWED**

PLAQUE SAMPLES COLLECTED AFTER A NONANOATE-GLUCOSE MOUTH RINSE @ PH 8.0 SHOWED LESS ACID FORMATION AND GLYCOLYSIS. NONANOATE IS EFFECTIVE IN THE PRESENCE OF SUGAR IN INHIBITING GLYCOLYSIS & PREVENTING LOW PH PRODN FROM CARBOHYDRATES WHICH ARE LIKELY TO BE HIGHLY CARIOGENIC.
[HAYES ML; ARCH ORAL BIOL 26 (3): 223 (1981)]**PEER REVIEWED**

FEMA NUMBER 2784
[Furia, T.E. (ed.). CRC Handbook of Food Additives. 2nd ed. Cleveland: The Chemical Rubber Co., 1972., p. 904]**PEER REVIEWED**

COMPOSITIONS CONTAINING PELARGONIC ACID ARE ATTRACTANTS FOR TABAKOSHIBANMUSHI (A PEST INSECT THAT INFESTS STORED FOODS AND TOBACCO).
[TABAKOSHIBANMUSHI ATTRACTANTS; JPN KOKAI TOKKYO KOHO PATENT NO 82 72901 05/07/82 (JAPAN TOBACCO AND SALT PUBLIC CORP)]**PEER REVIEWED**

EXPTL USE: PHARMACEUTICAL PREPN FOR TREATMENT OF ATHLETE'S FOOT CONTAIN NONYLIC ACID 1-20 PARTS. TOPICAL APPLICATION OF THE PREPN TOTALLY CONTROLLED THE INFECTION WITHIN 4 WK.
[ANZAI K; THERAPEUTIC AGENTS FOR ATHLETE'S FOOT; JAPAN KOKAI PATENT NO 77139729 11/21/77]**PEER REVIEWED**

EXPTL USE: BACTERICIDAL AND FUNGICIDAL TOPICAL MEDICATIONS CONTAIN PELARGONIC ACID. THE EFFICACY OF THIS PRODUCT FOR THE TREATMENT OF WOUND INFECTIONS IS DEMONSTRATED.
[TOPICAL MEDICATIONS FOR SKIN DISORDERS; JPN KOKAI TOKKYO KOHO PATENT NO 80162713 12/18/80 (YASUNISHI, KOSAKU)]**PEER REVIEWED**

Formulations/Preparations:

Grade: Technical 99%
[Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 12th

ed. New York, NY: Van Nostrand Rheinhold Co., 1993, p. 877]**PEER REVIEWED**

U. S. Production:

(1980) 9.75X10+9 GRAMS (EST CONSUMPTION)
PEER REVIEWED

(1981) PROBABLY GREATER THAN 6.81X10+6 GRAMS
PEER REVIEWED

Laboratory Methods:

Analytic Laboratory Methods:

SIMULTANEOUS GAS CHROMATOGRAPHIC SEPARATION OF A MIXT OF FATTY ACIDS, PHENOLS AND INDOLES INCL NONANOIC ACID IN CIGARETTE SMOKE IS DESCRIBED.
[HOSHIKA Y; J CHROMATOGR 144 (2): 181 (1977)]**PEER REVIEWED**

Special References:

Special Reports:

OPDYKE DL J; MONOGRAPHS ON FRAGRANCE RAW MATERIALS. PELARGONIC ACID; FOOD COSMET TOXICOL 16 (SUPPL 1): 839 (1978). A REVIEW WITH 44 REF ON PELARGONIC ACID INCL TOXICITY, IRRITATION, SENSITIZATION, METAB, ANTITUMOR ACTIVITY, PHARMACOL, AND EFFECT ON ENZYMES.

Synonyms and Identifiers:

Synonyms:

CIRRASOL 185A
PEER REVIEWED

EMFAC 1202
PEER REVIEWED

N-NONANOIC ACID
PEER REVIEWED

NONOIC ACID
PEER REVIEWED

N-NONOIC ACID
PEER REVIEWED

NONYLIC ACID
PEER REVIEWED

N-NONYLIC ACID
PEER REVIEWED

OCTANE-1-CARBOXYLIC ACID
PEER REVIEWED

PELARGIC ACID
PEER REVIEWED

PELARGONIC ACID
PEER REVIEWED

PELARGON (RUSSIAN)
PEER REVIEWED

Formulations/Preparations:

Grade: Technical 99%
[Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 12th ed. New York, NY: Van Nostrand Rheinhold Co., 1993, p. 877]**PEER REVIEWED**

Administrative Information:

Hazardous Substances Databank Number: 5554

Last Revision Date: 20030214

Last Review Date: Reviewed by SRP on 9/18/1997

Update History:

Complete Update on 02/14/2003, 1 field added/edited/deleted.
Complete Update on 11/08/2002, 1 field added/edited/deleted.
Complete Update on 08/06/2002, 1 field added/edited/deleted.
Complete Update on 01/14/2002, 1 field added/edited/deleted.
Complete Update on 08/09/2001, 1 field added/edited/deleted.
Complete Update on 05/15/2001, 1 field added/edited/deleted.
Complete Update on 06/12/2000, 1 field added/edited/deleted.
Complete Update on 02/08/2000, 1 field added/edited/deleted.
Complete Update on 02/02/2000, 1 field added/edited/deleted.
Complete Update on 09/21/1999, 1 field added/edited/deleted.
Complete Update on 08/27/1999, 1 field added/edited/deleted.
Complete Update on 06/03/1998, 1 field added/edited/deleted.
Complete Update on 03/10/1998, 1 field added/edited/deleted.

Complete Update on 12/15/1997, 32 fields added/edited/deleted.
Field Update on 11/01/1997, 1 field added/edited/deleted.
Complete Update on 04/23/1997, 6 fields added/edited/deleted.
Complete Update on 03/17/1997, 34 fields added/edited/deleted.
Complete Update on 01/30/1996, 1 field added/edited/deleted.
Complete Update on 01/05/1995, 1 field added/edited/deleted.
Complete Update on 04/04/1994, 1 field added/edited/deleted.
Field update on 01/08/1993, 1 field added/edited/deleted.
Complete Update on 10/10/1990, 1 field added/edited/deleted.
Complete Update on 04/16/1990, 1 field added/edited/deleted.
Field update on 12/29/1989, 1 field added/edited/deleted.
Complete Update on 01/16/1985

Exhibit C

REREGISTRATION ELIGIBILITY DOCUMENT

Soap Salts

LIST D

CASE 4083

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF PESTICIDE PROGRAMS
SPECIAL REVIEW AND REREGISTRATION DIVISION
WASHINGTON, D.C.

EPA SOAP SALTS REREGISTRATION ELIGIBILITY TEAM

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Margette Cogdell	Biological Analysis Branch
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Pat McLaughlin	Toxicology Branch II
Chris Swartz	Chemistry Branch II: Registration Support
Linda Kutney	Chemical Coordination Branch

Program Management and Support Division

BeWanda Alexander	Information Services Branch

Registration Division

Barbara Madden	Insecticide Rodenticide Branch
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Ian Blackwell	Registration Support Branch
Walter Francis	Antimicrobial Program Branch
Sami Malak	Antimicrobial Program Branch

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Veronica Dutch	Accelerated Reregistration Branch

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Office of General Counsel:
Alan Carpien

Office of Compliance Monitoring:
Beverly Updike

TABLE OF CONTENTS

GLOSSARY OF TERMS AND ABBREVIATIONS

A.I.	Active Ingredient
CAS	Chemical Abstracts Service
CFR	Code of Federal Regulations
CSF	Confidential Statement of Formula
EPA	U.S. Environmental Protection Agency
EP	End-Use Product
FDA	Food and Drug Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
GRAS	Generally Recognized As Safe
LC_{50}	Median Lethal Concentration. A statistically derived concentration of a substance that can be expected to cause death in 50% of test animals. It is usually expressed as the mass of substance per body mass of animal or volume of water or feed, e.g., mg/l or ppm.
LD_{50}	Median Lethal Dose. A statistically derived single dose that can be expected to cause death in 50% of the test animals when administered by the route indicated (oral, dermal, inhalation). It is expressed as a mass of substance per unit mass of animal, e.g. mg/kg.
MRID	Master Record Identification (number). EPA's system of recording and tracking studies submitted to the EPA.
ppm	Parts per Million
RED	Reregistration Eligibility Document
TGAI	Technical Grade of the Active Ingredient

EXECUTIVE SUMMARY

This Reregistration Eligibility Document (RED) addresses the pesticide active ingredients potassium and ammonium salts of fatty acids and their uses in the chemical case soap salts. Soap salts-containing products are currently registered as acaricides, algaecides, herbicides, insecticides and animal repellents. They are intended for either residential or commercial use. All applicable products containing potassium or ammonium salts of fatty acids as active ingredients and that registered for these uses are eligible for reregistration.

The U.S. Environmental Protection Agency (EPA) has conducted a review of the scientific data base and other relevant information supporting the reregistration of soap salts and has determined that the data base is sufficient to allow EPA to make a reregistration eligibility decision. All data requirements have been submitted or waived for these active ingredients.

Accordingly, EPA has determined that all products containing potassium or ammonium salts of fatty acids as the active ingredient are eligible for reregistration and will be reregistered when acceptable labeling and product specific data are submitted and/or cited. Before reregistering each product, the EPA is requiring that product specific data and revised labeling be submitted by the registrants within eight months of the issuance of this document. After reviewing these data and the revised labels, EPA will determine whether or not the conditions of FIFRA 3(c)(5) have been met, that is, whether product composition and labeling are acceptable and the product's uses will not cause unreasonable adverse effects to humans or the environment. If these conditions are met, EPA will reregister the product. Any end-use product containing soap salts in combination with other active ingredients will not be reregistered until the Agency issues reregistration eligibility decisions for all active ingredients contained in that product.

I. INTRODUCTION

In 1988, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was amended to accelerate the reregistration of products with active ingredients registered prior to November 1, 1984. The amended Act provides a schedule for the reregistration process to be completed in nine years. There are five phases to the reregistration process. The first four phases of the process focus on identification of data requirements to support the reregistration of an active ingredient and the generation and submission of data to fulfill the requirements. The fifth phase is a review by the U.S. Environmental Protection Agency (referred to as "the Agency") of all data submitted to support reregistration.

FIFRA Section 4(g)(2)(A) states that in Phase 5 "the Administrator shall determine whether pesticides containing such active ingredient are eligible for reregistration" before calling in data on products and either reregistering products or taking "other appropriate regulatory action." Thus, reregistration involves a thorough review of the scientific data base underlying a pesticide's registration. The purpose of the Agency's review is to reassess the potential hazards arising from the currently registered uses of the pesticide; to determine the need for additional data on health and environmental effects; and to determine whether the pesticide meets the "no unreasonable adverse effects" criterion of FIFRA.

This document presents the Agency's decision regarding the eligibility for reregistration of soap salts. The document consists of six sections. Section I is the introduction. Section II describes soap salts, their uses, data requirements and regulatory history. Section III discusses the human health and environmental assessment based on the data available to the Agency. Section IV discusses the eligibility for reregistration decision for soap salts. Section V discusses the reregistration requirements for soap salts. Section VI is the Appendices which support this Reregistration Eligibility Document. Additional details concerning the Agency's review of applicable data are available on request.[1]

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[1] EPA's reviews of data on the set of registered uses considered for EPA's analysis may be obtained from the OPP Public Docket, Field Operations Division (H7506C), Office of Pesticide Programs, EPA, Washington, DC 20460.

II. CASE OVERVIEW

A. Chemical Overview

The active ingredients potassium and ammonium salts of fatty acids are covered by this Reregistration Eligibility Document.

1. Chemical Name: Potassium salts of fatty acids [C_{12}-C_{18} saturated and C_{18} unsaturated], including potassium laureate, potassium myristate, potassium oleate and potassium ricinoleate.

CAS Registry Number: 10124-65-9

Office of Pesticide Programs Chemical Code: 0079201

Empirical Formula: $[C_{12}\text{-}C_{18}\ H_x\text{-}H_y\ O_x\text{-}O_y]K$

2. Chemical Name: Ammonium salts of higher fatty acids [C_8-C_{18} saturated and C_{18} unsaturated], including ammonium oleate.

CAS Registry Number: 84776-33-0

Office of Pesticide Programs Chemical Code: 031801

Empirical Formula: $[C_8\text{-}C_{18}\ H_x\text{-}H_y\ O_x\text{-}O_y]NH_4$

B. Use Profile For Potassium Salts of Fatty Acids

Mechanism of Action: Insects-- Disrupts the integrity of the exoskeleton by dissolving portions, causing body fluids to exude from the body and ultimately, death. Plants--Disrupts the photosynthetic process, thereby killing the plant.

Use Sites:

Terrestrial Food+Feed Crops: Beans, peas, tomatoes, white potatoes, seed and pod vegetables and other unspecified vegetables; nut crop/nut trees, citrus, pome fruits, subtropical fruits, grapes, trees and other unspecified fruit; and cotton.

Terrestrial Food Crops: Broccoli, brussels sprouts, cabbage, cauliflower, cucumber, eggplant, lettuce, melons, okra, pepper, pumpkins, radish, squash (summer), squash (winter), squash (zucchini), asparagus, and stone fruits.

Greenhouse Food Crops: fruit trees and other unspecified fruits.

Terrestrial Greenhouse Food Crops: asparagus, cucurbits, flavoring and spice crops, fruiting vegetables, leafy vegetables, root crop vegetables and other unspecified vegetables.

Indoor Residential: Adult dogs, puppies and cats.

Outdoor Residential: Walks, driveways, ornamental flower beds, trees and shrubs.

Pests:

Spider mites, whiteflies, aphids, squash bugs, flea beetles, green stink bugs, cabbageworms, leafhoppers, lace bugs, mealybugs, earwigs, grasshoppers, plant bugs, psyllids, sawfly larvae, scales, tent caterpillars, thrips, fleas, sarcoptic mange mites, wasp, hornets and ants. The potassium salts are also labeled to control mosses, algae, lichens, liverworts, and unspecified weeds.

Formulation Types Registered: Liquid and Solid

Single Active Ingredient Products:

Liquid concentrates: 18 to 50.5% potassium salts of fatty acids.
Solid Soap Cake: 25.0% potassium salts of fatty acids.

Ready to Use Sprays: 1.0 to 3.0% potassium salts of fatty acids.

Multiple Active Ingredient Products:

Solid soap cake: 89.0% potassium salts of fatty acids, 0.120% petroleum distillate, 0.084 N-Octyl bicycloheptene dicarboximide, 0.05% piperonal butoxide technical and 0.025% pyrethrins.

Liquid concentrates: 20.0% potassium salts of fatty acids, and 0.20% pyrethrins.
Ointment: 7.5% soap (anhydrous) and 30% benzyl benzoate.

Ready to Use Spray: 1.0% potassium salts of fatty acids and 0.01% pyrethrins.

Methods and Rates of Application:

Products containing potassium salts of fatty acids are applied as sprays, in a solid form ("soap cake"), and as an ointment. For specifics in application methods and rates on application methods and rates, please refer to Appendix A.

Limitations: None

C. Use Profile for Ammonium Salts of Fatty Acids

Mechanism of Action: Negatively affects the olfactory nerves of deer and rabbits.

Use Sites:

Terrestrial Food+Feed Crops: Grapes, cereal grains, unspecified vegetables, unspecified orchards, unspecified field crops, grass forage/fodder/hay and non-grass forage/fodder/hay.

Terrestrial Non-Food Crops: Ornamental herbaceous plants, ornamental lawns and turf, ornamental woody shrubs and vines and ornamental shade trees.

Pests:

Deer and rabbits

Formulation Type Registered: Liquid

Single Active Ingredient Products:

Liquid concentrates: 15.0% ammonium soaps of higher fatty acids.

Methods and Rates of Application:

Because of the variation in rates and methods of application of this chemical, please refer to Appendix A for methods and rates of application.

Limitations: Do not apply product through any type of irrigation system. Product is not compatible with soluble metallic salts such as zinc, manganese, and iron sulfates.

D. Regulatory History

The first soap salts product with pesticidal uses was registered in 1947. Currently there are twenty four "soap" products registered. The May 5, 1990 Federal Register publication of List D chemicals subject to reregistration, Soap Salts, case 4083, included soap, oleic acid, sodium oleate, ammonium oleate, potassium laureate, potassium myristate, potassium oleate and potassium ricinoleate. However previously in March of 1989 the Agency determined, "all potassium salts of fatty acids, and all combinations of these chemicals, to be a 'single active ingredient' for purposes of pesticide registration." An Agency review of May 4, 1992 determined that this position would only include potassium salts of C_{12}-C_{18}, saturated and unsaturated. "Any other chain length (either shorter or longer) should be considered a different active ingredient for registration purposes." Presently, of those chemicals included in Case 4083, only two active ingredients described above are currently associated with active product registrations. Products containing the remaining chemicals contained in this case (soap, as discussed below, oleic acid, and sodium oleate), are cancelled and these active ingredients have been removed from the list of chemicals subject to reregistration.

EPA published in the Federal Register of January 13, 1982 " an exemption from the requirement of a tolerance for residues of the insecticide potassium oleate and related C_{12}-C_{18} fatty acid potassium salts in or on all raw agricultural commodities when applied in accordance with good agricultural practices."

The Thompson-Hayward Chemical Company submitted an amendment to add food uses to the label of their registered product (EPA Reg. No. 1148-13) in July of 1979. This product, which was transferred December 29, 1982 to the Uniroyal Chemical Company (EPA Reg. No. 400-383) contains ammonium salts of fatty acids as the active ingredient. The Thompson-Hayward Company made a formal request for an exemption from the requirement of a tolerance for ammonium salts of fatty acids in a letter to the Agency dated September 10, 1980. The request was reviewed by the Agency which had no objections to the addition of food uses but required results of an inhalation test which was submitted and found acceptable. The addition of food uses was accepted in 1982.

Though the company made a formal request for an exemption of ammonium salts of fatty acids from the requirement of a tolerance and the Agency reviewed the data, a formal notice was not drafted and published in the Federal Register. To correct that oversight the Agency will draft a proposed exemption from tolerance and publish it in the Federal Register.

In the Federal Register Notice of May 4, 1988 and as set forth in 40 CFR §153.139, the Agency determined that "soap", "has no independent pesticidal activity when included in antimicrobial products for the designated uses, and thus is properly classified as an inert ingredient." Because EPA has determined that "soap" compounds is not an active ingredient but rather an inert in antimicrobial products, such products are not subject to the Soap Salts Reregistration Eligibility Document.

In accordance with the Pine Oil Label Improvement Program (Federal Register dated June 5, 1980 and PR Notice 80-1) the majority of labels for these antimicrobial products were revised to include "soap" as an inert ingredient. The Agency has issued a letter on May 5, 1992 notifying registrants of antimicrobial products that still have "soap" listed under the active ingredient statement that the label and Confidential Statement of Formula must be amended to delete "soap" from the active ingredient statement.

Although most registrants of antimicrobial products listing "soap" as an active ingredient have voluntarily amended their registrations to redesignate soap as inert, there remain a small number of registered antimicrobial products for which an amendment to effect this change has not been submitted to the EPA. While these products are not subject to the data requirements of the Soap Salts Reregistration Eligibility Document, the registrants of the products are being notified that the Agency considers antimicrobial products with "soap" listed on the label as an active ingredient to be misbranded under section 2(q)(1)(A) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Accordingly, unless these product labels are amended to delete soap as an active ingredient, the Agency may bring misbranding action under section 12(a)(1)(E) of FIFRA or may cancel such products under 6(b) of FIFRA.

The Food and Drug Administration lists salts of fatty acids, except ammonium, as additives that may be safely used in foods. This denotation appears in 21 CFR §172.863.

III. SCIENCE ASSESSMENT OF SOAP SALTS

The Agency has reviewed the scientific data base for soap salts, primarily relying on information from published literature submitted by the registrant. These sources of information are cited in Appendix C.

A. Product Chemistry Assessment

In the May 5, 1990 Federal Register publication of List D chemicals, Soap Salts, case 4083, included soap, oleic acid, ammonium oleate, sodium oleate, potassium laureate, potassium myristate, potassium oleate and potassium ricinoleate. By definition "ordinary soap is a mixture of the sodium salts of various fatty acids of natural oils and fats. It is made by heating oils with caustic soda, salting out the soluble soap formed, and drawing off the dilute glycerol produced. Thus, common soap is largely a mixture of the sodium salts of palmitic, stearic and oleic acids. The term soap is also applied to individual components such as sodium palmitate, sodium stearate, etc. If another metal or basic radical is present instead of sodium, a modified term such as potash soap, calcium soap or amine soap is used (1). This latter category also includes ammonium soaps (ammonium salts of fatty acids).

Case 4083, soap salts, are comprised of only two active ingredients which are currently associated with active product registrations. These two chemicals are: (1) ammonium salts of [C8-C18 saturated and C18 unsaturated] fatty acids, including ammonium oleate; and, (2) potassium salts of [C12-C18 saturated and C_{18} unsaturated] fatty acids, including potassium laureate, potassium myristate, potassium oleate, and potassium ricinoleate.

The technical grade of the active ingredient (TGAI) per se is not isolated during the manufacturing process. Given that these active ingredients are exempt from the requirement of a tolerance (40 CFR §180.1068), the Agency has not required generic data requirements to be satisfied using the TGAI as the test substance.

B. Human Health Assessment

1. Toxicology Data Base

The toxicological data base on soap salts is adequate and will support reregistration eligibility of the active ingredients.

a. Acute Toxicity

ACUTE TOXICITY DATA

TEST	EFFECT, CATEGORY
Oral LD50	IV
Dermal LD50	IV
Eye effects	Irritation
Skin effects	Mild - moderate irritation; Non-sensitizing

Oral exposure to soaps is generally self-limiting because the taste of soap is easily recognized and unpleasant. The ammonium soap salts also have a notable ammonia odor that is limiting. Fatty acids such as oleic acid and related C_{12}--C_{18} fatty acids are generally considered to be of low toxicity by the oral route of exposure, and potassium salts of these fatty acids are not expected to be very toxic. The oral LD50 for oleic acid in rats was 74 g/kg (14).

On human skin, 2.5 mg of soap for 24 hours caused moderate irritation; and 10 mg of soap on rabbit skin caused mild irritation (14). On human skin, 11,800 mg of the potassium salt of palmitic acid was irritating (15). For the potassium salt of caprylic acid, 7320 mg was irritating on human skin (15). Stearic acid was mildly irritating to human skin when 75 mg was applied intermittently for 3 days (15). On rabbit skin, 500 mg of stearic acid applied for 24 hours was moderately irritating (15). Oleic acid was moderately irritating to human skin when 15 mg was applied intermittently for 3 days; and mildly irritating to rabbit skin when 500 mg was applied (14).

The potassium salt of oleic acid was irritating when 12 mg were placed in rabbit eyes (48 hours) (14,15).

b. Metabolism

Fatty acids are normally metabolized by the cells, where they are oxidized to simple compounds for use as energy sources and as structural components utilized in all living cells. Potassium, sodium and ammonium are normally part of the body's metabolism and electrolyte balance.

c. Reproduction and Developmental Toxicity

When given to mice on days 2-13 of pregnancy, the potassium salts of coco fatty acids were reported to have an effect on post-implantation mortality at 6 gm/kg, and to cause musculo-skeletal system abnormalities at 600 mg/kg (15).

d. Mutagenicity

DNA inhibition was reported with 600 umol/l of the sodium salt of caprylic acid, tested with guinea pig kidney cells (15). Unscheduled DNA synthesis was found in mouse cells with 35 mg/kg of oleic acid (14). Cytogenetic analysis was positive for 2500 ug/L of oleic acid with hamster fibroblasts and for 100 mg/L with Saccharomyces cerevisiae (14).

2. Dietary Exposure

There is a tolerance exemption for potassium oleate and related C_{12}-C_{18} fatty acid potassium salts [40 CFR §180.1068]. Salts of fatty acids (not including ammonium salts) are food additives [21 CFR §172.863]. Residue chemistry data requirements are not applicable due to the tolerance exemption. While there are registered food uses for ammonium salts of fatty acids, there is neither a tolerance nor a tolerance exemption for these salts under 40 CFR Section 180. The Agency will correct this discrepancy by proposing a tolerance exemption.

3. Occupational and Residential Exposure

Products containing potassium salts of selected fatty acids are used on various crops, shrubs and trees, as well as household plants. Other uses include moss control in lawns as well as control of algae, lichens, and liverworts on roofs, walks, and fences, and in greenhouses. Ammonium salts of fatty acids are used as a rabbit and deer repellent on forage and grain crops, vegetables and field crops (unspecified), non-crop areas, nursery stock and ornamentals, flowers, roses, shrubs, fruit trees and vines.

The end-use product labels for the potassium salts of fatty acids bear the signal word "CAUTION" and do not recommend any measures to reduce exposure. The labels for the two end-use product labels for the ammonium soaps of higher fatty acids bear the signal word "DANGER" due to potential eye irritation and require that users wear protective eyewear, i.e., glasses, goggles, or faceshield, to protect against ocular exposure. The products may also cause allergic skin reactions in some individuals, however, no measures are recommended to reduce skin exposure because the Agency believes allergic reactions are uncommon and transient.

The toxicological data base on these soap salts is adequate and will support reregistration. Because the toxicity of these chemicals is generally low, the Agency is not requiring any exposure data. Exposure to users during application can be significant, but soaps generally have low toxicity to humans and, there is no reason to expect that pesticide use in accordance with use directions would constitute any significant hazard. Protective eyewear is required for ammonium soap salt products to mitigate potential ocular exposure and irritation for the ammonium salts of fatty acids.

4. Risk Assessment

Soaps are mineral salts of naturally occurring fatty acids. The fatty acids are a significant part of the normal daily diet, for they occur in dietary lipids which usually constitute about 90 grams in a day's diet. Residues from the pesticide uses are not likely to exceed levels of naturally occurring fatty acids in commonly eaten foods. The Food and Drug Administration lists salts of fatty acids, including the potassium salts, as additives that may be used as binders, emulsifiers, and anticking agents in food (21 CFR 172.863). Also, FDA lists oleic acid derived from tall oil fatty acids (21 CFR 172.862), and lists fatty acids, including capric, caprylic, lauric, myristic, oleic, palmitic, and stearic acids, (21 CFR 172.860) as additives that may be safely used in foods. Stearic acid is generally recognized as safe for use as an ingredient in food (21 CFR 184.1090). A number of fatty acid salts are prior sanctioned for uses in food packaging materials (21 CFR 181).

Because of the low acute toxicity (toxicity category IV) of soap salts via oral and dermal routes, and because residues from the pesticide uses are not likely to exceed levels of naturally occurring or intentionally added fatty acids in commonly eaten foods, the Agency believes the risks to applicators and consumers of treated foods are negligible. There is a risk of permanent eye injury to applicators but this risk can be mitigated by the use of eye wear protection, i.e., safety glasses, goggles or a faceshield. Protective eyewear is required for ammonium soap salt products to mitigate potential ocular exposure and irritation.

C. Environmental Assessment

The Agency has reviewed the data base for environmental effects for potassium and ammonium salts of fatty acids and has determined that the data base is adequate and will support reregistration.

1. Environmental Fate Assessment

Hydrolysis of potassium salts of fatty acids was shown not to occur over a period of 43 days (MRID 00164005). This is consistent with the literature on fatty acids, which indicates that the primary environmental degradation route of fatty acids is by microfloral action (the cleavage of the carbon chain of fatty acids by oxidative chemistry) as opposed to hydrolysis. Due to the similarity of chemical structure, it is expected that hydrolysis of the ammonium salts of fatty acid would be similar to that of the potassium salts of fatty acids.

Studies submitted to the Agency indicate that the half-life of these fatty acids is approximately less than one day (MRID 00157476). As can be expected, there is very rapid microbial degradation of fatty acids in soil. Fatty acids and their salts are excellent substrate for microbial growth, serving both as carbon sources, and as energy sources. The active ingredient cannot totally dissipate from soil, because there is a natural content of fatty acids in soil resulting from plant metabolism and by formation by microbial organisms. Fatty acids constitute a significant portion of the normal daily diet of mammals (including humans), birds, and invertebrates since they are found in large amounts in the form of lipids in all living tissues (including seeds). Potassium salts of fatty acids are naturally occurring. Microbial metabolism of fatty acids has the effect of either converting the degradates to CO_2 and ester (if used as an energy source) or converting the carbon content of the fatty acid to any of the thousands of naturally occurring organic substances produced by the soil microflora (if used as a carbon source).

2. Ecological Hazard Assessment for Ammonium Salts of Fatty Acids

Topical summaries addressing each data requirement:

(i.) Effects on Birds

Three studies were submitted by Uniroyal Chemical Company Inc. to determine the effect of ammonium salts of fatty acid on birds. The three studies were determined to be supplemental because test material used in the study was reported to be only 14.65 percent pure.

Author	Date	MRID No.
Pederson	1991	41767112
Pederson	1991	41767113
Pederson	1991	41767114

To establish the toxicity of ammonium of fatty acids to birds, the following tests are required using the technical grade material (TGAI).

A. One avian single-dose oral study on either a waterfowl species (mallard duck) or an upland species (bobwhite quail).

B. Two subacute dietary studies: one study on a species of upland game bird(bobwhite quail) and one study on a waterfowl species (mallard duck).

Studies submitted included:

Study and Species	% A.I.	LD/LC50	Date	MRID	Fulfills Requirement
71-1 Avian Oral-					
Bobwhite Quail	14.65	2,150 ppm	1/91	41767112	Y
71-2					
Bobwhite Quail-	14.65	5,000 ppm	1/91	41767113	Y
Mallard Duck	14.65	5,000 ppm	1/91	41767114	Y

Although these avian studies are classified as supplemental (the active ingredient was determined to be only 14.65 % pure) data could be used to satisfy the data requirement. The oral LD50 was determined to be 2,150 ppm for mature bobwhite quail given a single oral dose of ammonium salts of fatty acids (Pederson, 1991, MRID 41767112). The results of 8-day dietary studies (Pederson, 1991, MRID's 41767113 and 41767114) indicate that the LC50 for ammonium soap salts is greater than 5,000 ppm for both mallard ducks and bobwhite quail. The available data indicate that ammonium salts of fatty acids is practically non-toxic to upland game birds and waterfowl.

Precautionary Labeling

The available toxicity data do not indicate a requirement of precautionary labeling for birds on products containing Ammonium salts of fatty acids.

(ii.) Effects on Freshwater Invertebrates

No studies were received on ammonium salts of fatty acids for freshwater invertebrates. Minimum data requirement to establish the acute toxicity of ammonium salts of fatty acids to freshwater invertebrates includes:

A. A 48-hour acute study using the technical grade material. Test organisms should be first installed *Daphnia magna*.

Data for aquatic invertebrates used in the hazard assessment were derived from tests conducted on Potassium Salts of Fatty Acids. Science staff determined that the chemical properties for all soap salts were very similar. Although this does not necessarily mean the biological effects are similar, the Ecological Effects Branch has tentatively concluded that the worst case scenario for Ammonium Salts of Fatty Acids is not likely to be significantly different than Potassium Salts of Fatty Acids. The core study for Potassium soap salts indicates that potassium soap salts are highly toxic ($LC_{50} = 0.57$ ppm) to freshwater invertebrates (MRID 400662-00).

Precautionary Labeling

This product may be hazardous to aquatic invertebrates. Do not apply directly to water, areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water by cleaning of equipment or disposal of water.

(iii.) Effects on Freshwater Fish

The minimum data required for establishing the acute toxicity of ammonium salts of fatty acids to freshwater fish are two 96-hour freshwater fish studies with the technical grade active ingredient. The following studies are required:

A. One 96-hour study with a coldwater fish species (preferable rainbow trout)

B. One 96-hour study performed with a warmwater fish species (preferably bluegill sunfish).

No studies using ammonium salts of fatty acids were submitted under this topic; however, a tentative position can be taken that because of the similarities of soap salts, the potassium salts of fatty acid data can probably be substituted for ammonium salts of fatty acids.

Two tests were performed on freshwater fish using the potassium salt technical grade material. The LC50's were determined to be 18.06 ppm and 35.35 ppm for trout and bluegill respectively. One study with the typical end-use product performed on fathead minnows produced a LC50 of 21 ppm. These data indicate that potassium soap salts, and by presumption, ammonium soap salts are slightly toxic to both coldwater and warmwater fish species.

Precautionary Labeling

The available acute toxicity data indicate that precautionary labeling for fish toxicity is not required.

(iv.) Effects on Non-Target Insects

No studies were received on the effects of ammonium salts of fatty acids on non-target insects.

Precautionary Labeling

Precautionary labeling will be required if data to be submitted indicates a significant risk.

3. Ecological Hazards Assessment for Potassium Salts of Fatty Acids

Topical summaries addressing each data requirement:

(i.) Effects on Birds

Seventeen studies were submitted from 2 different companies to determine the effect of potassium salts of fatty acid (soap salts) on birds. Seven of the 17 studies submitted were acceptable for use in the risk assessment. Ten of the studies can be used to supplement the core data used in the risk assessment.

Author	Date	MRID No.
Grimes	1987	94240004 (TGAI)
Grimes	1987	94240004 (TEP)
Grimes	1987	94240005 (TGAI)
Grimes	1987	94240005 (TEP)
Grimes	1987	94240005
Wildlife Int. Ltd.	1981	00096639A
Wildlife Int. Ltd.	1981	00096639B
Wildlife Int. Ltd.	1981	00157472
Wildlife Int. Ltd.	1981	00010504 (2 studies)

To establish the toxicity of potassium salts of fatty acids to birds, the following tests are required using the technical grade material (TGAI).

A. One avian single-dose oral study on either a waterfowl species (preferably mallard duck) or an upland species (preferably bobwhite quail).

B. Two subacute dietary studies: one study on a species of upland game bird (preferably bobwhite quail and one study on a species of waterfowl (preferably mallard duck).

The acceptable acute oral toxicity studies are listed below:

Data Requirements	Test Substance	Bibliographic Citation	Validation	Company	Results
AVIAN TESTING					
71-1 Avian Oral Bobwhite	TEP	94240004	Supplemental	Reuter	LD50= >2,250 mg/kg
	TGAI	94240004	Core	Reuter	LD50= >2,000 mg/kg
Mallard Duck	TGAI	00096639B	Supplemental	Safer	LD50= >2,510 mg/kg
	TGAI	00096639A	Supplemental	Safer	LD50= >2,510 mg/kg

EXHIBIT D

2007 Organic Herbicide Trial

Richard Smith, Farm Advisor
University of California Cooperative Extension, Monterey County

Methods: Conducted at the Hartnell East Campus in Salinas, CA. The soil type at the site is Chualar Loam soil with 2.2% organic matter and pH of 7.4. Beds were shaped and 0.75 inch of sprinkler irrigation water was applied to beds on May 14 and 21 to germinate and establish weed populations. Each plot was one 40-inch bed wide by 15 feet long and replicated four times in a randomized complete block design.

The trial was initiated on June 7, 2007 when a single, post-emergence application of each of the herbicide treatments was made. The weeds at the time of application were 3 weeks old and were generally small. All materials were applied with a CO_2 backpack sprayer at 30 psi using a single nozzle wand. The nozzle tip was a Teejet 8004E and two passes of the wand were made over each plot applying the equivalent of 40 GPA.

Weed control evaluations (percent control ratings 0 – 100 scale: 0 = no control to 100 = 100% weed control) were made on June 11, June 15 and June 21, which were 4, 8 and 14 days after treatment (DAT), respectively. Weed control ratings were made of the 5 major weeds present at the site and total weed control ratings were calculated from the average weed control of each species. The weed control assessment data were analyzed by using an analysis of variance and mean separation was Fishers Protected LSD (P=0.05).

Results: Increasing rates of Scythe improved weed control on all evaluation dates (Tables 1, 2 & 3). In particular higher rates of Scythe were needed to control burning nettle. Matran EC provided only partial control of the weeds at both the low and high rates tested. In particular it was weak on purslane, but moderately effective on the other weed species present. Racer provided moderate weed control at the lower rate, but effective in controlling all weed species at the higher rate. Natures Avenger provided good initial control but some of the weeds recovered from the application, and as a result, at 8 and 14 DAT it provided moderate weed control; it was particularly effective on purslane. Liberty was included as a chemical control for comparison purposes and was highly effective in controlling all weed species, especially at the 8 and 14 DAT evaluations.

Table 1. Weed control ratings (percent control: rating of 0 – 100) on June 11 (4 DAT)

Material	Rate	Shepherd's Purse	Burning Nettle	Purslane	Malva	Hairy Nightshade	Total Weeds
Scythe 4.2 EC	3.0% v/v	60.0	35.0	42.5	37.5	33.6	40.0
Scythe 4.2 EC	6.0% v/v	85.0	60.0	68.7	100.0	63.6	69.0
Scythe 4.2 EC	9.0% v/v	95.0	90.0	98.7	100.0	90.0	90.0
Matran EC Natural Wet[1] Sulfur	5.0% v/v 0.25% v/v 5 lbs/A	77.5	35.0	40.0	55.0	42.5	50.0
Matran EC Natural Wet[1] Sulfur	8.0% v/v 0.25% v/v 5 lbs/A	77.5	72.5	55.0	80.0	67.5	70.5
Racer[2]	2.0% wt/v	70.0	52.5	78.5	45.0	41.9	50.5
Racer[2]	6.0% wt/v	95.0	87.5	85.0	100.0	100.0	88.5
Natures Avenger 23 EC	25.0 % v/v	90.0	75.0	92.5	80.0	85.0	84.5
Liberty 1.67 EC	0.5 lb a.i./A	95.0	82.5	87.5	77.5	100.0	88.5
Untreated	---	0.0	0.0	0.0	0.0	0.0	0.0
LSD (0.05)		3.9	4.6	7.0	4.8	12.0	5.8

1- Natural wet is an organically acceptable spreader

Table 2. Weed control ratings (percent control: rating of 0 – 100) on June 15 (8 DAT)

Material	Rate	Shepherd's Purse	Burning Nettle	Purslane	Malva	Hairy Nightshade	Total Weeds
Scythe 4.2 EC	3.0% v/v	60.0	37.5	55.0	45.0	40.2	45.5
Scythe 4.2 EC	6.0% v/v	87.5	80.0	87.5	100.0	92.5	89.5
Scythe 4.2 EC	9.0% v/v	97.5	92.5	100.0	100.0	95.0	97.0
Matran EC Natural Wet[1] Sulfur	5.0% v/v 0.25% v/v 5 lbs/A	50.0	45.0	12.5	60.0	42.5	72.0
Matran EC Natural Wet[1] Sulfur	8.0% v/v 0.25% v/v 5 lbs/A	72.5	62.5	52.5	85.0	77.5	70.0
Racer[2]	2.0% wt/v	47.5	42.5	60.0	45.0	53.6	47.0
Racer[2]	6.0% wt/v	100.0	92.5	85.0	85.0	99.7	87.5
Natures Avenger 23 EC	25.0 % v/v	27.5	42.5	75.0	67.5	47.5	52.0
Liberty 1.67 EC	0.5 lb a.i./A	100.0	100.0	100.0	100.0	100.0	100.0
Untreated	---	0.0	0.0	0.0	0.0	0.0	0.0
LSD (0.05)		3.9	3.6	6.2	7.1	5.5	4.3

1- Natural wet is an organically acceptable spreader

Table 3. Weed control ratings (percent control: rating of 0 – 100) on June 21 (14 DAT)

Material	Rate	Shepherd's Purse	Burning Nettle	Purslane	Malva	Hairy Nightshade	Total Weeds
Scythe 4.2 EC	3.0% v/v	45.0	35.0	47.5	45.0	60.0	46.5
Scythe 4.2 EC	6.0% v/v	82.5	72.5	90.0	100.0	100.0	89.0
Scythe 4.2 EC	9.0% v/v	95.0	92.5	97.5	100.0	97.5	96.5
Matran EC Natural Wet[1] Sulfur	5.0% v/v 0.25% v/v 5 lbs/A	55.0	50.0	15.0	55.0	60.0	47.0
Matran EC Natural Wet[1] Sulfur	8.0% v/v 0.25% v/v 5 lbs/A	55.0	65.0	25.0	82.5	55.0	56.5
Racer[2]	2.0% wt/v	27.5	40.0	57.5	37.5	72.5	47.0
Racer[2]	6.0% wt/v	97.5	92.5	92.5	100.0	100.0	96.5
Natures Avenger 23 EC	25.0 % v/v	37.5	45.0	75.0	60.0	52.5	54.0
Liberty 1.67 EC	0.5 lb a.i./A	100.0	100.0	100.0	100.0	100.0	100.0
Untreated	---	0.0	0.0	0.0	0.0	0.0	0.0
LSD (0.05)		5.0	4.1	6.4	4.8	4.2	2.3

1- Natural wet is an organically acceptable spreader

Table 4. Summary of weed control ratings (percent control: rating of 0 – 100) on June 15 and total weeds on June 21

Material	Rate	June 15						June 21
		Shepherd's Purse	Burning Nettle	Purslane	Malva	Hairy Nightshade	Total Weeds	Total Weeds
Scythe 4.2 EC	3.0% v/v	60.0	37.5	55.0	45.0	40.2	45.5	46.5
Scythe 4.2 EC	6.0% v/v	87.5	80.0	87.5	100.0	92.5	89.5	89.0
Scythe 4.2 EC	9.0% v/v	97.5	92.5	100.0	100.0	95.0	97.0	96.5
Matran EC Natural Wet[1] Sulfur	5.0% v/v 0.25% v/v 5 lbs/A	50.0	45.0	12.5	60.0	42.5	72.0	47.0
Matran EC Natural Wet[1] Sulfur	8.0% v/v 0.25% v/v 5 lbs/A	72.5	62.5	52.5	85.0	77.5	70.0	56.5
Racer[2]	2.0% wt/v	47.5	42.5	60.0	45.0	53.6	47.0	47.0
Racer[2]	6.0% wt/v	100.0	92.5	85.0	85.0	99.7	87.5	96.5
Natures Avenger 23 EC	25.0 % v/v	27.5	42.5	75.0	67.5	47.5	52.0	54.0
Liberty 1.67 EC	0.5 lb a.i./A	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Untreated	---	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LSD (0.05)		3.9	3.6	6.2	7.1	5.5	4.3	2.3

1- Natural Wet is an organically acceptable spreader

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EXHIBIT E

AgAlert®
THE WEEKLY NEWSPAPER FOR CALIFORNIA AGRICULTURE

REPRINT
February 4, 2009

Field trials bring new hope for natural tomato herbicides

By Bob Johnson

Farmers spend more money every year controlling weeds than controlling insect pests and diseases combined. And weed control bills figure to keep rising as diesel prices drive up the cost of cultivation.

The problem is particularly severe for growers who are trying to produce a crop without synthetic chemicals, because there is a dire shortage of organic materials that can effectively control weeds without damaging the crop.

But help may be on the way.

University of California Cooperative Extension weed specialist Tom Lanini notes that there are some promising trials of organic herbicides being conducted by UC researchers.

"Fear of uncontrolled weeds is frequently a factor inhibiting the adoption of organic practices," Lanini said. "Development of effective and economical natural-product herbicides has the potential to both improve soil and environmental quality in organic and specialty cropping systems, and to reduce expenses for farmers."

The products in the weed control trials include oils and acids, and they are being used with and without surfactants at different volumes and concentrations. They are being looked at as post-emergent herbicides.

All of the products are being tested in three different trials—at tomato plots in Davis, an organic vineyard in Napa County and lettuce plots.

"The goal is to evaluate as many natural herbicide products as we could," said Shosha Capps, a UC Davis graduate student who is conducting the trials in cooperation with Lanini.

In the Napa vineyard trial, which was done in cool weather, the materials were generally quite a bit better at controlling smaller weeds than larger weeds. There was better control of larger weeds with a second application of some of the materials in the Davis tomato trial, which was done in warmer weather.

"So far we've seen the best results from Racer and from acetic acid at 20 percent concentration," Capps said as she pointed to some nearly weed-free tomato plots. "We got close to 100 percent control with the Racer when we applied it twice."

Racer is 40 percent ammonium pelargonate and is not yet registered in California, but it is registered nearly everywhere else and is on the list of materials allowable in organic production. It can be applied multiple times at concentrations up to 6 percent, but should not be applied directly to water.

The acetic acid gave 85 percent weed control when it was applied a second time at 20 percent concentration. Acetic acid is vinegar but because 20 percent is a far higher concentration that common vinegar, some-

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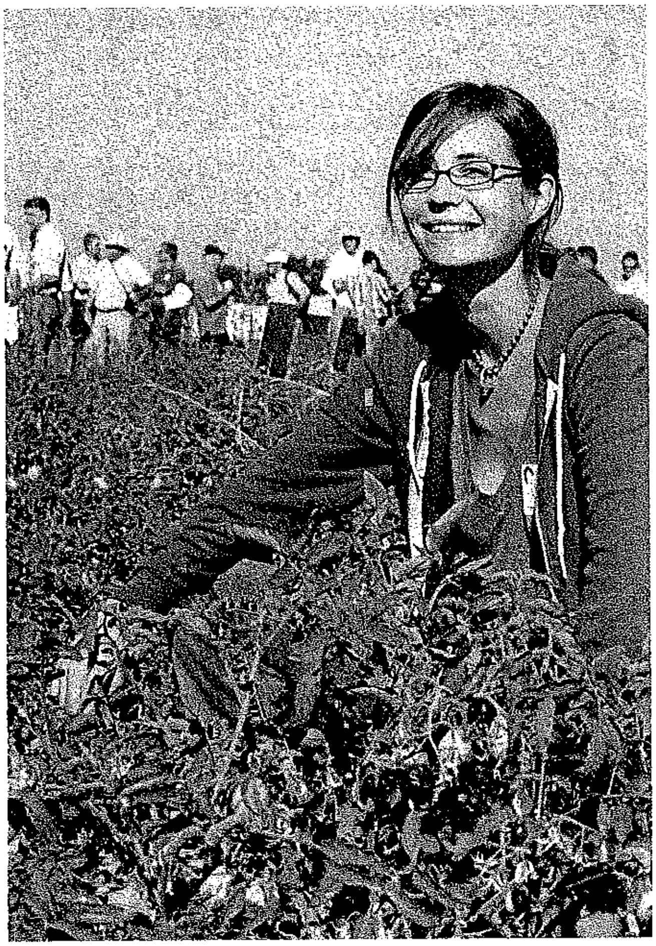

one would have to test and register a product to make it allowable for commercial use.

The researchers are also learning more about how to apply natural weed control products to make them more effective.

Higher volumes make most of the materials more effective. Applying higher concentrations of the active material also helps the effectiveness of most of the materials. But between the two, increasing the volumes helps more than increasing the concentration.

The use of surfactants NuFilm P, NuFilm 17 and Natural Wet also generally improved the effectiveness of the materials.

And all weeds are not alike when it comes to susceptibility to these milder weed control products.

Lambs quarter was generally the hardest of the weeds to kill, and pigweed was the easiest.

The trials also appear to have a memorable failure.

An increasing number of growers are including mustards in cover crop mixes because they release a natural fumigant that may help reduce disease and weed pests in the soil.

But an attempt to use a concentrated mustard meal as an herbicide has, so far, proven to be a singular failure.

"The only weeds the mustard meal is controlling are the tomatoes and the nightshade," Lanini said.

An additional practical issue is that it would take three acres to grow enough mustard to make the mustard meal needed to treat just one acre. The mustard meal in the trial also looks to have included some viable seeds that have sprouted and could bring one more variety of mustard weeds to the site.

The discovery of natural weed control products frequently involves a perplexing process of trial and error.

In the greenhouse, GreenMatch EX, Racer, Matran and Raps were the most effective materials in the current trials. But the order of performance changed significantly once the materials were put to the test in the field.

Years ago many researchers found in the greenhouse that corn gluten has herbicidal qualities.

But UCCE weed specialist Clyde Elmore said he was never able to repeat his lone success controlling weeds in the field with corn gluten. Elmore recalled a trial in a field of ornamental annuals near Watsonville, in which corn gluten was effective against purslane.

He tried 30 times to repeat the trial and never achieved weed control. And he said he was never able to figure out what he had done differently in the Watsonville flower field. But he did find that corn gluten, which is very high in nitrogen, makes a good fertilizer.

(Bob Johnson is a reporter in Magalia. He may be contacted at bjohn11135@aol.com.)

EXHIBIT F

Racer Efficacy Study - Bixby

Fall 2007

Lynn Brandenberger, Charles Webber III, James Shrefler, and Lynda Wells
Oklahoma State University

Introduction and objective: Weed control is a serious concern for commercial vegetable producers because of the limited number of herbicides available for this group of minor crops and the potential for crop injury. Organic producers of vegetables have an even bigger challenge since their weed control tools are limited to cultural methods exclusively. One method of weed control used in conventional production is the stale seed-bed where planting beds are prepared and weeds are allowed to germinate and are subsequently controlled by the application of a contact herbicide with no residual activity. After existing weeds are controlled then seed or transplants are planted directly into the seed-bed. This method has appeal for a number of reasons, but organic producers have not been able to utilize this method for lack of an organic material that could be used as a contact herbicide. Additional uses for an organic contact herbicide would also include post directed applications with directed sprays and hooded sprayers. Racer (ammonium nonanoate) is labeled for non-food use and efforts are currently underway to label it as a bio-herbicide for organically grown food crops. The main component of Racer is ammonium nonanoate which occurs in nature and is primarily formed from biodegradation of higher fatty acids. The objective of this study was to investigate different nozzles, rates of active ingredients, and overall rates of spray material for the control of endemic weed populations.

Methods: The study was completed at the Oklahoma State University Vegetable Research station in Bixby, Oklahoma. Plots were arranged in a randomized complete block design with four replications, each plot consisted of an area 10 feet wide by 15 feet long. The entire experimental area was disk-harrowed then cultivated using a "Do-all" finish cultivator on 8/30/07. Treatments were applied on 9/13/07 using a tractor mounted CO_2 sprayer with 3 nozzles with a 20-inch nozzle spacing for a total spray width of 60 inches. To maintain the same spray pattern for each nozzle type, the nozzle pressure was held constant and tractor speed was adjusted to achieve different overall application rates i.e. 35 or 70 gallons per acre (gpa). Treatments included two nozzle types operated at recommended nozzle pressures (TeeJet XR8003 at 59 psi and TeeJet XR8005 at 83 psi), three application concentrations of Racer (8.0, 11.2, and 14.4 lbs ai/a), and two application volumes (35 and 70 gpa) for a total of 12 treatments (Table 1). Plots were rated on 9/14/07, 9/17/07, and 9/20/07 for percent control of Palmer amaranth (*Amaranthus palmeri* S. Watts.), carpetweed (*Mollugo verticillata* L.), and crabgrass (*Digitaria* species) on a 0 to 100% scale 0% = no weed control and 100% = complete control i.e. dead plants. Also included on the same dates were counts of the three different weed species within a 0.1 meter^2 area that was flagged on the first count for each plot with successive counts taken at the same area within the plot. Live weed species were counted if there was any green tissue visible on the plants. Plants that exhibited no green tissue were not counted.

Results and discussion: In general, herbicidal activity on weed populations that were present in the study was observed as burning and subsequent necrosis of plant tissues that were present at the time of application. This is normal for other contact herbicides such as paraquat that are used as "burn-down" materials. Depending on the weed species, some plants began to recover during the seven day period that plots were rated, but all weed species were adversely affected. Regarding rates of Racer, the lowest rate (8.0 lbs ai/acre) did not perform as well compared to higher rates of 11.2 and 14.4 lbs ai/acre (Tables 1 and 2). This was true for all three weed species included in the study. Generally speaking, a greater number of 8003 nozzle treatments had higher levels of control than the 8005 treatments, but the 8005-35-11.2 treatment had the highest rating for nine of the twelve ratings that were taken.

Palmer amaranth control from Racer was highest on 9/14/07 for the 8003-35-11.2, 8003-35-14.4, 8005-35-11.2, 8005-35-14.4, and 8003-70-14.4 which ranged from 96 to 93% control (Table 1). On 9/17/07, Palmer amaranth control was highest for 8005-35-11.2, 8003-70-14.4, 8005-35-14.4, 8003-35-11.2, and 8003-70-11.2 and ranged from 89 to 73% control. Treatment 8005-35-11.2 recorded 91% control on 9/20/07, the highest level of Palmer Amaranth control for that date.

Racer control of carpet weed was high with several treatments providing 100% control of this weed species on 9/14/07 (Table 1). 8003-35-11.2, 8003-35-14.4, 8005-35-11.2, 8005-35-14.4, 8003-70-14.4, and 8005-70-14.4 ranged from 100 to 97% control for carpet weed on 9/14/07. Carpet weed control decreased somewhat for the second and third ratings, but on the last day, ratings were still 92% and above for six of the twelve treatments.

Crabgrass control ranged from 88 to 95% on 9/14/07 for 8003-35-11.2, 8003-70-11.2, 8003-35-14.4, 8005-35-11.2, 8005-35-14.4, and 8003-70-14.4 (Table 2). On 9/20/07 four treatments, 8003-70-11.2, 8003-70-14.4, 8005-35-11.2, and 8005-35-14.4 had ratings of 91% and above.

Only carpet weed on 9/17/07 and 9/20/07 varied significantly for number of live weeds (Table 3), the remainder of weed species and dates did not vary for number of live weeds present. On 9/17/07 all treatments except for 8003-70-8 had significantly fewer carpetweeds than the untreated check. Of the treatments that had lower numbers of live carpetweeds 8005-35-14.4, 8005-70-14.4, and 8005-35-11.2 recorded zero, 0.3, and 0.3 weeds compared to the untreated check that had 5.0 weeds per 0.1 M^2. On 9/20/07, all Racer treatments had fewer live carpetweeds than the untreated check. Treatments including 8005-35-14.4, 8005-70-14.4, and 8003-35-11.2 had 0.3 to 0. 5 live carpetweeds per 0.1 M^2.

In general, Racer proved to be an effective contact herbicide for controlling the three weed species that were included in the study. The two higher rates of Racer (11.2 and 14.4 lbs ai/acre) were more effective than the 8.0 lbs ai/acre rate, although even the low rate resulted in higher levels of weed control than the untreated check. It appears that the overall spray application rate of 70 gpa probably diluted the active ingredient enough to reduce its effectiveness. Based upon the results, the authors would recommend further study to determine if similar results would be observed during a different season with different conditions, but would recommend examining rates of 11.2 and 14.4 lbs ai/acre and overall application rates of 35 gpa.

Acknowledgements: The authors wish to thank U.S.D.A. Interregional Project # 4 (IR-4) and Falcon Lab LLC for their support of this research.

Table 1. 2007 Racer efficacy study, Bixby, OK, Control of weedy species.

Treatments[y]	Palmer amaranth % control of weedy species[z]			Carpet Weed % control of weedy species		
Nozzle-gpa-ai	9/14/07	9/17/07	9/20/07	9/14/07	9/17/07	9/20/07
Check	0 e[x]	0 d	0 e	0 c	0 d	0 c
8003-35-8	60 b-c	61 a-b	70 a-d	75 a-b	74 a-b	66 a-b
8003-70-8	31 c-d	28 c	50 d	79 a-b	49 c	44 b
8003-35-11.2	96 a	75 a	84 a-c	100 a	95 a	92 a
8003-70-11.2	78 a-b	73 a	79 a-c	97 a	94 a	93 a
8003-35-14.4	96 a	66 a-b	85 a-b	100 a	95 a	94 a
8003-70-14.4	93 a	86 a	85 a-b	98 a	97 a	92 a
8005-35-8	44 c-d	43 b-c	63 b-d	91 a-b	80 a-b	70 a-b
8005-70-8	24 d-e	18 c-d	60 b-d	68 b	55 b-c	49 b
8005-35-11.2	94 a	89 a	91 a	100 a	99 a	95 a
8005-70-11.2	40 c-d	44 b-c	58 c-d	91 a-b	75 a-b	73 a-b
8005-35-14.4	93 a	85 a	75 a-d	99 a	99 a	93 a
8005-70-14.4	58 b-c	66 a-b	76 a-c	97 a	89 a	71 a-b

[z] Percent control of individual weedy species.

[y] Treatments=Nozzle type, gpa=gallons per acre, ai=lbs active ingredient per acre.

[x] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Table 2. 2007 Racer efficacy study, Bixby, OK, Control of weedy species.

Treatments[y]	Crabgrass			Total		
	% control of weedy species[z]			% control of all weedy species		
Nozzle-gpa-ai	9/14/07	9/17/07	9/20/07	9/14/07	9/17/07	9/20/07
Check	0 d[x]	0 d	0 d	0 f	0 f	0 d
8003-35-8	50 c	50 c	59 c	77 c	64 b-d	65 b-c
8003-70-8	56 b-c	56 b-c	59 c	63 d	39 e	55 c
8003-35-11.2	91 a	91 a	89 a-b	95 a	88 a	88 a-b
8003-70-11.2	88 a	88 a	91 a-b	90 a	85 a-b	88 a-b
8003-35-14.4	90 a	90 a	89 a-b	96 a	83 a-b	88 a-b
8003-70-14.4	95 a	95 a	91 a-b	93 a	88 a	87 a-b
8005-35-8	75 a-c	75 a-c	64 c	84 a-b	56 c-e	66 b-c
8005-70-8	48 c	48 c	70 b-c	58 c	48 d-e	64 b-c
8005-35-11.2	93 a	93 a	96 a	95 a	93 a	95 a
8005-70-11.2	73 a-c	73 a-c	78 a-c	75 a-c	74 a-c	68 b-c
8005-35-14.4	91 a	91 a	91 a-b	96 a	90 a	86 a-b
8005-70-14.4	80 a-b	80 a-b	88 a-b	85 a-b	81 a-b	84 a-b

[z] Percent control of individual weedy species.

[y] Treatments=Nozzle type, gpa=gallons per acre, ai=lbs active ingredient per acre.

[x] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Table 3. 2007 Racer efficacy study, Bixby, OK, Number of live weeds by species.

Treatments[y]	Palmer amaranth			Carpet Weed			Crab grass		
	Number of live weeds in 0.1 M^{2}[z]								
Nozzle-gpa-ai	9/14/07	9/17/07	9/20/07	9/14/07	9/17/07	9/20/07	9/14/07	9/17/07	9/20/07
Check	3.0 a[x]	2.3 a	2.3 a	4.5 a	5.0 a	6.0 a	24 a	19 a	22 a
8003-35-8	1.0 a	1.0 a	1.0 a	3.3 a	0.5 b-c	1.0 b	40 a	33 a	32 a
8003-70-8	1.8 a	1.5 a	1.8 a	5.5 a	3.0 a-b	2.5 b	24 a	21 a	23 a
8003-35-11.2	1.0 a	1.0 a	1.0 a	4.3 a	0.8 b-c	0.5 b	27 a	12 a	13 a
8003-70-11.2	1.0 a	0.8 a	0.8 a	5.5 a	1.0 b-c	0.8 b	18 a	15 a	18 a
8003-35-14.4	1.5 a	1.3 a	1.8 a	6.8 a	0.5 b-c	0.8 b	26 a	13 a	15 a
8003-70-14.4	1.0 a	0.3 a	0.5 a	6.5 a	0.5 b-c	1.3 b	37 a	23 a	23 a
8005-35-8	2.0 a	1.0 a	1.3 a	4.0 a	1.5 b-c	1.3 b	37 a	32 a	30 a
8005-70-8	1.8 a	1.5 a	2.0 a	4.0 a	2.3 b-c	2.0 b	27 a	26 a	26 a
8005-35-11.2	1.3 a	0.8 a	0.8 a	7.8 a	0.3 c	1.0 b	21 a	17 a	18 a
8005-70-11.2	2.0 a	1.3 a	1.0 a	4.0 a	1.0 b-c	1.3 b	22 a	25 a	20 a
8005-35-14.4	3.5 a	2.5 a	2.8 a	5.0 a	0.0 c	0.3 b	31 a	16 a	17 a
8005-70-14.4	2.8 a	0.8 a	1.5 a	8.5 a	0.3 c	0.3 b	41 a	30 a	29 a

[z] Number of live weeds by species in 0.1 M^{2}.

[y] Treatments=Nozzle type, gpa=gallons per acre, ai=lbs active ingredient per acre.

[x] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Racer Efficacy Study - Lane

Fall 2007

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Introduction and objective: This study parallels the Racer Efficacy Study that was conducted at Bixby, Oklahoma in the fall of 2007. Racer (ammonium nonanoate) is labeled for non-food use and efforts are currently underway to label it as a bio-herbicide for organically grown food crops. The main component of Racer is ammonium nonanoate which occurs in nature and is primarily formed from biodegradation of higher fatty acids. The objective of this study was to investigate different nozzles, rates of active ingredients, and overall rates of spray material for the control of endemic weed populations.

Methods: The study was conducted at the Lane Agriculture Center at Lane, Oklahoma. Plots were arranged in a randomized complete block design with four replications, each plot measuring 10 feet wide by 15 feet long. The entire experimental area was disk-harrowed then cultivated using a "Do-all" finish cultivator on 8/30/07. Treatments were applied on 9/18/07 using a tractor mounted CO_2 sprayer with 3 nozzles with a 20-inch nozzle spacing for a total spray width of 60 inches. To maintain the same spray pattern for each nozzle type, the nozzle pressure was held constant and tractor speed was adjusted to achieve different overall application rates i.e. 35 or 70 gallons per acre (gpa). Treatments included two nozzle types operated at recommended nozzle pressures (TeeJet XR8003 at 59 psi and TeeJet XR8005 at 83 psi), three application concentrations of Racer (8.0, 11.2, and 14.4 lbs ai/a), and two application volumes (35 and 70 gpa) for a total of 12 treatments (Table 1). Plots were rated on 9/19/07, 9/22/07, and 9/25/07 for percent control of tumble pigweed (Amaranthus albus.) and goosegrass (Eleusine indica) on a 0 to 100% scale 0% = no weed control and 100% = complete control i.e. dead plants. Carpetweed (Mollugo verticillat) was evaluated at the first two evaluation dates and cutleaf evening primrose was evaluated at the final evaluation date. Also included on the same dates were counts of all weed species (except for cutleaf evening primrose) within a 0.1 meter^2 (1.17 ft^2) area that was flagged on the first count for each plot with successive counts taken at the same area within the plot. Live weed species were counted if there was any green tissue visible on the plants. Plants that exhibited no green tissue were not counted.

Results and discussion: In general, herbicidal activity on weed populations present in the study was observed as burning and necrosis of plant tissues present at the time of application. This is typical for contact herbicides that function as "burn-down" materials. Depending on the weed species, plants not completely killed began to recover during the seven day period that plots were rated. In general, weed control increased with increased herbicide rate (Tables 1 and 2). This was true for all weed species in the study except for cutleaf evening primrose. For cutleaf evening primrose mean control was never greater than 25%. Generally speaking, a greater number of 8005 nozzle treatments had higher levels of control than the 8003 nozzle treatments.

Tumble pigweed control from Racer was as great as 90% (Table 1) and generally as high as 80% with the highest rates at the earliest two evaluations. At the third evaluation ratings were generally below 80%. Exceptions were the combination of the highest application rates and pressures.

Racer control of carpetweed was high with several treatments providing 90%+ control of this weed species on 9/19/07 (Table 1) and control generally remained as great at the 9/22 rating. Rating at 9/25 was not possible due to grass present in some plots.

Goosegrass control was as high as 80% on 9/19/07 (Table 2). Significant decreases in control were found for the intermediate rate compared to the high rate. On 9/25/07 control was no greater than 50%.

There were no significant changes in number of live weeds (Table 3) for any of the evaluation dates.

In general, Racer provided partial to substantial control of three of the weed species that were evaluated. Only minimal control of cutleaf evening primrose was observed. There were general tendencies of increased control with increased herbicide rate. Based upon the results, the authors recommend further study to determine if similar results would be observed during a different season with different conditions, but would recommend examining rates of 11.2 and 14.4 lbs ai/acre and possibly greater rates. Overall application rates of should also be further examined

Acknowledgements: The authors wish to thank U.S.D.A. Interregional Project # 4 (IR-4) and Falcon Lab LLC for their support of this research.

Table 1. 2007 Racer efficacy study, Lane, OK, control of weedy species.

Treatments[y]	Tumble pigweed			Carpetweed		Cutleaf evening primrose
	% control of weedy species[z]					
Nozzle-gpa-ai	9/19/07	9/22/07	9/25/07	9/19/07	9/22/07	9/25/07
Check	0 g[x]	0 g	0 e	0 d	0 d	0 c
8003-35-8	50 d-e	60 d-f	47 cd	69 bc	55 c	15 ab
8003-70-8	35 e-f	50 ef	50 cd	55 c	66 bc	12 a-c
8003-35-11.2	67 b-c	62 c-f	60 a-d	86 ab	79 ab	10 ab
8003-70-11.2	70 a-c	77 a-d	72 a-c	84 ab	80 ab	20 ab
8003-35-14.4	86 a	77 a-c	55 b-d	96 a	96 a	17 ab
8003-70-14.4	87 a	86 ab	80 ab	91 a	92 a	17 ab
8005-35-8	70 a-c	67 b-d	42 d	84 ab	87 a	12 a-c
8005-70-8	25 f	47 f	45 cd	50 c	47 c	12 a-c
8005-35-11.2	82 ab	64 c-f	62 a-d	98 a	91 a	12 a-c
8005-70-11.2	86 cd	81 a-c	72 a-c	94 a	89 a	15 ab
8005-35-14.4	86 a	89 a	65 a-d	99 a	98 a	17 ab
8005-70-14.4	86 a	90 a	85 a	98 a	99 a	25 a

[z] Percent control of individual weedy species.

[y] Treatments=Nozzle type, gpa=gallons per acre, ai=lbs active ingredient per acre.

[x] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Table 2. 2007 Racer efficacy study, Lane, OK, control of weedy species.

Treatments[y]	Goosegrass			Total	
	% control of weedy species[z]			% control of all weedy species	
Nozzle-gpa-ai	9/19/07	9/22/07	9/25/07	9/19/07	9/22/07
Check	0 h[x]	0 f	0 f	0 f	0 f
8003-35-8	42 fg	40 de	15 ef	47 d	49 de
8003-70-8	32 g	37 e	17 de	35 e	46 e
8003-35-11.2	50 ef	52 b-e	27 b-e	57 cd	65 bc
8003-70-11.2	55 d-f	57 bc	35 a-d	59 cd	67 a-c
8003-35-14.4	66 b-d	55 b-d	25 c-e	74 ab	66 bc
8003-70-14.4	70 a-c	62 b	40 a-c	75 ab	77 ab
8005-35-8	57 c-e	45 c-e	22 c-e	59 cd	60 cd
8005-70-8	32 g	37 e	20 de	35 e	45 e
8005-35-11.2	66 b-d	60 bc	50 a	75 ab	75 ab
8005-70-11.2	62 b-e	57 bc	35 a-d	62 bc	67 a-c
8005-35-14.4	75 ab	62 b	45 ab	76 a	76 ab
8005-70-14.4	81 a	80 a	45 ab	85 a	81 a

[z] Percent control of individual weedy species.

[y] Treatments=Nozzle type, gpa=gallons per acre, ai=lbs active ingredient per acre.

[x] Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Table 3. 2007 Racer efficacy study, Lane, OK, Number of live weeds by species.

Treatments^{y}	**Tumble pigweed**			**Carpetweed**			**Goosegrass**		
				Number of live weeds in 0.1 m^{2z}					
Nozzle-gpa-ai	**9/19/07**	**9/22/07**	**9/25/07**	**9/19/07**	**9/22/07**	**9/25/07**	**9/19/07**	**9/22/07**	**9/25/07**
Check	2.0 a^{x}	2.5 a	2.2 a	0.2 a	0.7 a	0.7 a	19 a	19 a	10 a
8003-35-8	1.5 a	1.5 a	1.5 a	1.0 a	0.2 a	0.5 a	21 a	33 a	14 a
8003-70-8	0.5 a	0.5 a	0.5 a	1.0 a	1.0 a	1.0 a	27 a	21 a	16 a
8003-35-11.2	2.0 a	1.5 a	2.2 a	1.2 a	0.5 a	1.0 a	23 a	12 a	15 a
8003-70-11.2	0.0 a	0.0 a	0.2 a	0.2 a	0.5 a	0.7 a	33 a	15 a	18 a
8003-35-14.4	1.5 a	0.5 a	1.2 a	0.7 a	1.2 a	0.7 a	23 a	13 a	15 a
8003-70-14.4	2.7 a	0.7 a	1.5 a	1.0 a	1.0 a	1.2 a	24 a	23 a	17 a
8005-35-8	0.5 a	0.5 a	0.2 a	0.2 a	0.0 a	0.2 a	27 a	32 a	16 a
8005-70-8	0.7 a	0.5 a	0.5 a	2.7 a	2.2 a	2.0 a	29 a	26 a	19 a
8005-35-11.2	2.5 a	2.0 a	2.2 a	1.7 a	0.7 a	1.0 a	22 a	17 a	12 a
8005-70-11.2	1.5 a	0.2 a	1.2 a	1.0 a	1.0 a	1.5 a	27 a	25 a	20 a
8005-35-14.4	1.2 a	0.2 a	1.0 a	1.0 a	0.7 a	0.7 a	22 a	16 a	12 a
8005-70-14.4	0.7 a	0.5 a	0.7 a	1.2 a	0.7 a	1.2 a	25 a	30 a	19 a

^{z}Number of live weeds by species in 0.1 m^{2}.

^{y}Treatments=Nozzle type, gpa=gallons per acre, ai=lbs active ingredient per acre.

^{x}Numbers in a column followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Racer as a Potential Organic Herbicide

Application Volumes and Herbicide Rates
2006

Charles L. Webber III, Lynn P. Brandenberger, James W. Shrefler, Lynda K. Wells, and Kent Shannon

Introduction and Objective: Racer (40% ammonium pelargonate/ammonium nonanoate) is labeled for non-food use and efforts are currently underway to label it as a bio-herbicide for organically grown food crops. The main component of Racer is ammonium pelargonate which occurs in nature and is primarily formed from biodegradation of higher fatty acids. The objective of this study was to investigate impact of application rates and volumes on the weed control efficacy of Racer on endemic weed populations.

Materials and Methods: The field experiment was conducted on Bernow fine sandy loam, 0-3% slope (fine-loamy, siliceous, thermic Glossic Paleudalf) at Lane, OK. The experiment consisted of 9 weed control treatments, which included 2 herbicide rates (6.4 and 9.6 lb/a) applied at 4 application volumes (17.5, 35, 70, and 105 gpa), plus an untreated weedy-check (Table 1). The entire experimental area was disk-harrowed then cultivated using a "Do-all" finish cultivator to establish a suitable seedbed for weed growth. Plots were arranged in a randomized complete block design with four replications, each plot consisted of an area 10 ft wide by 15 ft long.

Racer[1, 2] (40% ammonium pelargonate) was applied as a broadcast application on September 12 using a tractor mounted CO_2 sprayer equipped with four extended range, stainless steel, 0.3 gallons/min nozzles[3], on 20-inch spacings at a spraying height of 20 inches. To maintain the same spray pattern for each weed control treatment, the nozzle pressure was held constant and tractor speed adjusted to achieve the different overall application rates (17.5, 35, 70, and 105 gpa). At the time of spraying it was clear and calm, 70°F, and 82% relative humidity. At the time of spraying pigweeds, tumble (*Amaranthus albus* L.) and spiny (*Amaranthus spinosus*), were 1 – 1.5 inch tall, carpetweeds (*Mollugo verticillata* L.) were 1.0 inch across with 5 – 7 leaves, and grasses, goosegrass (*Eleusine indica* L. Gaertn.), and smooth crabgrass (*Digitaria* isahaemum (Schreb. ex Schweig) Schreb. Ex Muhl.) had 2 – 3 leaf shoots, each about 2-3 inches long.

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[1] Falcon Lab LLC, 1103 Norbee Drive, Wilmington, DE 19803

[2] The mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.

[3] XR TeeJet, XR8003VS, Spraying Systems Co., P.O. Box 7900, Wheaton, IL 60189-7900.

Plots were rated on September 18, 6 DAT, for percent weed control on a 0 to 100% scale, where 0% equals no weed control and 100% equals complete control (i.e. dead plants). All data was subjected to ANOVA[4] and mean separation using LSD with P=0.05. The weed rating data was prepared for analysis using a square root arcsine transformation.

Results and Discussion: In general, the application of Racer produced greater weed control for the broadleaf weed species (tumble pigweed, spiny pigweed, and carpetweed) than the grass weeds (goosegrass and smooth crabgrass) (Table 1). Although all of the Racer applications produced significantly greater weed control for all weed species compared to the weedy-check, there were no significantly differences among Racer applications for grass weed control. Grass weed control ranged from 30 to 52.5% for goosegrass and 22.5 to 52.50% for smooth crabgrass. The range and magnitude of the broadleaf weed control was much greater than the grass weed control. The best weed control for both pigweed species occurred at the 9.6 lb/a rate applied at 70 gpa. Carpetweed was very sensitive to Racer, producing 65% at the lowest application rate and volume, and most application rates and volumes producing, at least, 85% control.

Table 1. Impact of Racer application volumes and herbicide rates on weed control 6 days after treatment (6 DAT).

Trt #	Volume gpa	Rate (lb/a)	Tumble Pigweed		Spiny Pigweed		Carpetweed		Goose Grass		Smooth Crabgrass	
1	0	0	0.00	e^z	0.00	f	0.00	c	0.00	b	0.00	b
2	17.5	6.4	42.50	d	35.00	e	65.00	b	32.50	a	22.50	a
3	17.5	9.6	80.00	abc	75.00	abc	93.25	a	47.50	a	42.50	a
4	35	6.4	52.50	bcd	52.50	bcde	90.00	a	30.00	a	27.50	a
5	35	9.6	78.75	ab	77.50	ab	93.25	a	52.50	a	50.00	a
6	70	6.4	50.00	cd	42.50	cde	72.50	ab	32.50	a	30.00	a
7	70	9.6	93.75	a	93.75	a	87.00	ab	51.25	a	45.00	a
8	105	6.4	42.50	d	35.00	de	75.00	ab	32.50	a	37.50	a
9	105	9.6	60.00	bcd	67.50	abcd	91.25	a	50.00	a	52.50	a

^{z}Values followed by the same letters within columns are not significant at the P = 0.05 level.

The factorial analysis determined that there were no significant differences among application volumes when averaged across the herbicide application rates (Table 2). Although not significantly different, there was a tendency for pigweed control to peek at the 70 gpa application volume. Weed control for all weed species was significantly greater for the 9.6 lb/a application rate compared to the 6.4 lb/a (Table 3). Whether comparing the impact of application volume (17.5, 35, 70, and 105

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[4] SAS Institute Inc., 100 SAS Campus Drive, Cary, NC 27513.

gpa) or application rates (6.4 and 9.6 lb/a), weed control was the greatest for carpetweed, then the pigweeds, and lastly the grass weeds.

Table 2. Influence of Racer applications averaged across application rates (6.4 and 9.6 lb/a) at 6 days at treatment (6 DAT).

GPA gal/a	Tumble Pigweed		Spiny Pigweed		Carpet-weed		Goose Grass		Crabgrass	
17.5	61.25	a[z]	55.00	a	79.13	a	40.00	a	32.50	a
35	65.63	a	65.00	a	91.63	a	41.25	a	38.75	a
70	71.88	a	68.13	a	79.75	a	41.88	a	37.50	a
105	51.25	a	51.25	a	83.13	a	41.25	a	45.00	a

[z] Values followed by the same letters within columns are not significant at the P = 0.05 level.

Table 3. Influence of Racer applications averaged across application volumes (17.5, 35, 70, and 105 gpa 6 days at treatment (6 DAT).

Rates (lb/a)	Tumble Pigweed		Spiny Pigweed		Carpet-weed		Goose Grass		Crabgrass		Carpet-weed	
6.4	46.88	b[z]	41.25	b	75.63	b	31.88	b	29.38	b	75.63	b
9.6	78.13	a	78.44	a	91.19	a	50.31	a	47.50	a	91.19	a

[z] Values followed by the same letters within columns are not significant at the P = 0.05 level.

Conclusions: These results indicate that Racer has an excellent potential as an effective organic herbicide if it achieves the proper clearance. As with other contact herbicides, organic and non-organic herbicides, Racer provide great weed control for broadleaf weeds than grass weeds. It is also important to note provide consistent control across a large range of application volumes.

Acknowledgements: The authors thank Falcon Lab, LLC, 1103 Norbee Drive, Wilmington, DE 19803 for provide Racer material for field trials and appreciate Buddy Faulkenberry for maintaining the field experiments and data collection.

EXHIBIT G

University of Delaware
Natural Herbicide Weed Control

Trial ID: NE1026-08 Cooperator: Mark VanGessel
Location: Field #22 Investigator: Mark VanGessel

NOTE: Flor BL and Ida Gold are mustard varieties. The seeded rows had foliar overlap which interered with spray co
onto leaves when not thinned. Thinning to one plant per 3 inches resulted in better spray coverage.
Fresh and dry weight of mustard indicate subjective control rating.
Data entries with asterisk indicate computer generated missing data numbers. Weeds were missing in some
Weeds were missing in some plots when no entry.

Weed or Crop Name					Flor BL	Flor BL	Ida Gold	Ida Gold	Common	Pigweed	Flor BL	Ida Gold	Pigweed	Common	Flor BL
Weed or Crop Name					mustard	mustard	mustard	mustard	ragweed	spp	mustard	mustard	spp	ragweed	mustard
Rating Data Type					Control	Control	Control	Control	Control	Control	Control	Control	Control	Control	FreshWt
Rating Unit					%	%	%	%	%	%	%	%	%	%	grams
Rating Date					7/16/2008	7/16/2008	7/16/2008	7/16/2008	7/16/2008	7/16/2008	7/25/2008	7/25/2008	7/25/2008	7/25/2008	7/25/200
Crop Stage					Thinned	Not Thnd	Thinned	Not Thnd			Thinned	Thinned			Thinned
Eval. Interval, Unit					5 DA	5 DA	5 DA	5 DA	5 DA	5 DA	14 D	14 D	14 D	14 D	14 D
Trt No.	Treatment Name	Product Rate	Product Rate Unit	Plot											
1	VINEGAR (5%)	11.9	gal/A	101	75	50	80	65	45.0*	25	80	80	20	20	3.76
	YUCCA	9	fl oz/A	211	78	65	78	75	45	35	80	88	25	35	5.87
	H2O	58	gal/A	302	72	65	78	70	60	35	70	70	35	27.5*	8.61
	(70 gpa spray vol)			404	75	65	75	75	30	30	60	65	20	27.5*	11.97
				Mean =	75	61.3	77.8	71.3	45	31.3	72.5	75.8	25	27.5	7.553
2	VINEGAR (10%)	23	gal/A	102	80	70	80	75	60	45	90	95	50	50	1.09
	YUCCA	9	fl oz/A	207	80	72	85	80	60.0*	60	78	95	50	50.0*	3.89
	H2O	47	gal/A	312	80	80	88	85	60.0*	50	100	100	50	50.0*	0.63
	(70 gpa spray vol)			402	88	70	80	75	60.0*	50	88	100	40	50.0*	1.6
				Mean =	82	73	83.3	78.8	60	51.3	89	97.5	47.5	50	1.803
3	VINEGAR (15%)	35	gal/A	103	85	75	90	82	.	58	90	100	50	40.0*	1.03
	YUCCA	9	fl oz/A	212	90	75	85	78	.	65	100	98	45	40	0
	H2O	35	gal/A	308	95	78	90	80	.	65	100	100	40	40.0*	0
	(70 gpa spray vol)			401	88	78	85	85	.	65	85	95	50	40.0*	2.18
				Mean =	89.5	76.5	87.5	81.3	.	63.3	93.8	98.3	46.3	40	0.803
4	VINEGAR (20%)	47	gal/A	104	100	80	100	88	.	70	100	100	70	.	0
	YUCCA	9	fl oz/A	209	92	30	85	80	.	78	99	100	70	.	0
	H2O	23	gal/A	303	95	82	88	82	.	75	92	92	60	.	1.78
	(70 gpa spray vol)			411	100	85	98	90	.	70	100	100	75	.	0
				Mean =	96.8	69.3	92.8	85	.	73.3	97.8	98	68.8	.	0.445
5	MATRAN II	1.75	gal/A	105	68	65	75	75	40.0*	20	70	70	20	20.0*	14.69
	HUMASOL	3.5	qt/A	208	58	40	75	68	50	30	60	60	15	20.0*	8.54
	H2O	32.4	gal/A	310	65	55	50	40	30	25	60	45	20	20	6.54
	(35 gpa spray vol)			406	60	35	60	30	40	35	58	60	25	20.0*	28.19
				Mean =	62.8	48.8	65	53.3	40	27.5	62	58.8	20	20	14.49

Trt No.	Treatment Name	Product Rate	Product Rate Unit	Plot	Flor BL mustard Control % 7/16/2008 Thinned 5 DA	Flor BL mustard Control % 7/16/2008 Not Thnd 5 DA	Ida Gold mustard Control % 7/16/2008 Thinned 5 DA	Ida Gold mustard Control % 7/16/2008 Not Thnd 5 DA	Common ragweed Control % 7/16/2008 5 DA	Pigweed spp Control % 7/16/2008 5 DA	Flor BL mustard Control % 7/25/2008 14 D	Ida Gold mustard Control % 7/25/2008 14 D	Pigweed spp Control % 7/25/2008 14 D	Common ragweed Control % 7/25/2008 14 D	Flor BL mustard FreshWt grams 7/25/200 14 D
6	MATRAN II	3.5	gal/A	106	85	60	80	70	50	40	85	88	55	50.0*	1.48
	HUMASOL	3.5	qt/A	210	80	60	68	60	50	50	88	75	55	50	1.59
	H2O	30.6	gal/A	307	78	60	75	65	43.3*	50	70	78	50	50	9.55
	(35 gpa spray vol)			410	85	70	90	80	30	40	72	80	50	50.0*	2.63
				Mean =	82	62.5	78.3	68.8	43.3	45	78.8	80.3	52.5	50	3.813
7	MATRAN II	5.25	gal/A	107	80	60	80	60	65	40	75	88	65	.	10.75
	HUMASOL	3.5	qt/A	202	90	65	70	65	60.0*	55	100	80	70	.	0
	H2O	29	gal/A	306	85	68	88	82	55	65	85	92	65	.	4.15
	(35 gpa spray vol)			409	90	78	90	85	60.0*	55	95	100	40	.	0
				Mean =	86.3	67.8	82	73	60	53.8	88.8	90	60	.	3.725
8	MATRAN II	7	gal/A	108	85	65	82	70	60	50	90	98	45	.	1.61
	HUMASOL	3.5	qt/A	203	85	70	75	68	60	50	95	85	35	.	6.11
	H2O	27	gal/A	311	82	70	78	75	60.0*	60	75	80	55	.	6.37
	(35 gpa spray vol)			407	90	75	85	80	60.0*	65	85	90	60	.	2.93
				Mean =	85.5	70	80	73.3	60	56.3	86.3	88.3	48.8	.	4.255
9	RACER.....AMMON	9.6	fl oz/gal	109	85	80	85	80	40	65	85	90	60	40	2.8
	H2O	65	gal/A	201	88	75	85	80	65	55	95	100	75	45.0*	1.25
	(70 gpa spray vol)			305	98	85	90	85	70	60	100	100	80	50	0
				403	95	80	88	75	50	65	100	100	75	45.0*	0
				Mean =	91.5	80	87	80	56.3	61.3	95	97.5	72.5	45	1.013
10	RACER.....AMMON	16.6	fl oz/gal	110	90	78	88	78	68	60	95	98	60	60	0.48
	H2O	61	gal/A	204	100	75	95	90	68.0*	70	100	100	70	57.5*	0
	(70 gpa spray vol)			309	100	88	90	85	68.0*	78	100	100	60	55	0
				412	100	90	100	90	68.0*	75	100	100	65	57.5*	0
				Mean =	97.5	82.8	93.3	85.8	68	70.8	98.8	99.5	63.8	57.5	0.12
11	RACER.....AMMON	16.6	fl oz/gal	111	100	65	90	65	50	60	100	100	45	40	0
	H2O	30.5	gal/A	206	95	70	85	75	50.0*	65	98	88	45	40.0*	0
	(35 gpa spray vol)			304	95	78	88	70	50	60	92	85	60	40.0*	1.61
				408	90	75	88	80	50.0*	60	70	92	55	40.0*	1.69
				Mean =	95	72	87.8	72.5	50	61.3	90	91.3	51.3	40	0.825
12	UNTREATED CHECK			112	0	0	0	0	0	0	0	0	0	0	18.81
				205	0	0	0	0	0	0	0	0	0	0	45.18
				301	0	0	0	0	0	0	0	0	0	0	56.03
				405	0	0	0	0	0	0	0	0	0	0	163.84
				Mean =	0	0	0	0	0	0	0	0	0	0	70.965

intact

plots

Flor BL mustard Dry Wght grams 8/5/2008 Thinned 25 D	Ida Gold mustard FreshWt grams 7/25/200 Thinned 14 D	Ida Gold mustard Dry Wght grams 8/5/2008 Thinned 25 D
0.39	0.63	0.47
1.06	1.21	0.392
2.22	5.69	0.954
2.28	6.34	1.29
1.4875	3.468	0.7765
0.03	1.49	0.04
1.06	0.89	0.04
0.04	1.3	0.04
0.02	0	0
0.2875	0.92	0.03
0.03	0	0
0	3.41	0.95
0	0	0
0.023	0	0
0.0133	0.853	0.2375
0	0	0
0	0	0
0.03	0.48	0.01
0	0	0
0.0075	0.12	0.0025
3.98	39.79	2.75
1.767	3.47	0.49
1.92	6.84	1.34
6.27	6.57	1.12
3.4843	14.168	1.425

Flor BL mustard Dry Wght grams 8/5/2008	Ida Gold mustard FreshWt grams 7/25/200	Ida Gold mustard Dry Wght grams 8/5/2008
25 D	14 D	25 D
0.302	2.05	0.427
0.44	2.56	0.39
2.18	4.43	1.079
0.52	2.02	0.02
0.8605	2.765	0.479
2.66	4.73	1.24
0	5.02	1
1	3.38	0.68
0	0	0
0.915	3.283	0.73
0.17	0	0
1.269	3.7	0.79
1.57	1.74	0.315
0.87	2.68	0.89
0.9698	2.03	0.4988
0.76	0.89	0.02
0.122	0.86	0.01
0	0	0
0	0.81	0.017
0.2205	0.64	0.0118
0.004	0	0
0	0	0
0	0	0
0	0	0
0.001	0	0
0	0	0
0	3.18	0.69
0.28	4.13	0.841
0.28	2.24	0.089
0.14	2.388	0.405
3.443	7.38	1.84
10.76	40.24	9.77
2.517	25.11	4.96
28.86	78.67	14.72
11.395	37.85	7.8225

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Efficacy of Natural Herbicide Products for Annual Weed Control

Trial ID: NATPRODS08 Protocol ID: NATPRODS08
Location: ROCK SPRINGS Study Director: CURRAN
Project ID: Investigator: Dr. William S. Curran

01-06-10A08:06 CFMD

EXHIBIT H

Trial Location

City: PA Furnace
State/Prov.: PA
Postal Code: 16865

Pest Description

Pest 1 Type: W **Code:** SETFA Setaria faberi
Common Name: Giant foxtail

Pest 2 Type: W **Code:** ABUTH Abutilon theophrasti
Common Name: Velvetleaf

Pest 3 Type: W **Code:** CHEAL Chenopodium album
Common Name: Common lambsquarters

Pest 4 Type: W **Code:** AMARE Amaranthus retroflexus
Common Name: Redroot Pigweed

Pest 5 Type: W **Code:** BRSJU Brassica juncea
Common Name: Brown mustard

Pest 6 Type: W **Code:** SINAL Brassica alba
Common Name: Yellow Mustard
Description: IDA Gold

Site and Design

Plot Width, Unit: 5 FT
Plot Length, Unit: 10 FT
Plot Area, Unit: 50 FT2
Replications: 4 **Study Design:** RACOBL Randomized Complete Block (RCB)

Application Description

	A
Application Date:	7/11/2008
Time of Day:	12:30 PM
Application Method:	SPRAY
Application Timing:	POST
Application Placement:	BROFOL
Applied By:	DJS
Air Temperature, Unit:	87 F
% Relative Humidity:	39
Wind Velocity, Unit:	4 MPH
Dew Presence (Y/N):	N no
Soil Temperature, Unit:	82 F
% Cloud Cover:	40

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Pest Stage At Each Application

	A
Pest 1 Code, Type, Scale:	SETFA W
Height, Unit:	5 IN
Height Minimum, Maximum:	4 6
Pest 2 Code, Type, Scale:	ABUTH W
Height, Unit:	2 IN
Height Minimum, Maximum:	1.5 2.5
Pest 3 Code, Type, Scale:	CHEAL W
Height, Unit:	1.5 IN
Height Minimum, Maximum:	1.5 2.5
Pest 4 Code, Type, Scale:	AMARE W
Height, Unit:	2.5 IN
Height Minimum, Maximum:	2 2.5
Pest 5 Code, Type, Scale:	BRSJU W
Height, Unit:	4.5 IN
Height Minimum, Maximum:	3 5
Pest 6 Code, Type, Scale:	SINAL W
Height, Unit:	7 IN
Height Minimum, Maximum:	5.5 8.5

Application Equipment

	A
Appl. Equipment:	HANDHELD
Equipment Type:	SPRBAC
Operating Pressure, Unit:	38 PSI
Nozzle Type:	FLAT FAN
Nozzle Size:	11002AI
Nozzle Spacing, Unit:	15 IN
Boom Length, Unit:	7.5 FT
Boom Height, Unit:	18 IN
Ground Speed, Unit:	3 MPH
Carrier:	WATER
Spray Volume, Unit:	20 GPA
Mix Size, Unit:	1.8 LITERS
Propellant:	CO2

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Efficacy of Natural Herbicide Products for Annual Weed Control

Trial ID: NATPRODS08 Protocol ID: NATPRODS08

Pest Code								BRSJU	BRSJU	BRSJU
Pest Name								Brown mustard	Brown mustard	Brown mustard
Rating Date								7/16/2008	7/25/2008	7/25/2008
Rating Type								CONTRO	CONTRO	WEIFRE
Rating Unit								%	%	g/m2
Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Other Rate Unit	Appl Description	1	2	3
1	UNTREATED						POST	0.0 f	0.0 c	954.40 a
2	VINEGAR (5%) (70 GPA)	100	SL	17	% v/v	gal/a	POST	42.5 e	10.0 c	414.90 b
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST			
3	VINEGAR (10%) (70 GPA)	100	SL	33	% v/v	gal/a	POST	66.3 c	27.5 b	323.40 b
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST			
4	VINEGAR (15%) (70 GPA)	100	SL	50	% v/v	gal/a	POST	75.0 bc	61.3 a	210.00 b
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST			
5	VINEGAR (20%) (70 GPA)	100	SL	67	% v/v	gal/a	POST	78.8 ab	70.0 a	210.40 b
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST			
6	MATRAN EC (5%) (35 GPA)	100	EC	5	% v/v	gal/a	POST	53.8 d	35.0 b	376.80 b
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST			
7	MATRAN EC (10%) (35 GPA)	100	EC	10	% v/v	gal/a	POST	63.8 c	35.0 b	275.00 b
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST			
8	MATRAN EC (15%) (35 GPA)	100	EC	15	% v/v	gal/a	POST	68.8 bc	38.8 b	356.60 b
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST			
9	MATRAN EC (20%) (35 GPA)	100	EC	20	% v/v	gal/a	POST	71.3 bc	65.0 a	210.50 b
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST			
10	RACER (70 GPA)	100	SL	6.5	% v/v	gal/a	POST	71.3 bc	75.0 a	319.80 b
11	RACER (35 GPA)	100	SL	13	% v/v	gal/a	POST	85.0 a	73.8 a	317.85 b
12	GREENMATCH EX (70 GPA)	100	SL	10	% v/v	gal/a	POST	65.0 c	45.0 b	433.05 b
	NUFILM P	100	SL	0.25	% v/v	fl oz/a	POST			
LSD (P=.05)								7.54	15.73	151.587
Standard Deviation								5.22	10.90	104.984
CV								8.46	24.38	28.61

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Pest Code								BRSJU	SINAL	SINAL
Pest Name								Brown mustard	Yellow mustard	Yellow mustard
Rating Date								7/25/2008	7/16/2008	7/25/2008
Rating Type								WEIDRY	CONTRO	CONTRO
Rating Unit								g/m2	%	%
Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Other Rate Unit	Appl Description	4	5	6
1	UNTREATED						POST	125.00 a	0.0 e	0.0 f
2	VINEGAR (5%) (70 GPA)	100	SL	17	% v/v	gal/a	POST	62.63 b	45.0 d	13.8 ef
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST			
3	VINEGAR (10%) (70 GPA)	100	SL	33	% v/v	gal/a	POST	51.80 b	70.0 c	30.0 de
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST			
4	VINEGAR (15%) (70 GPA)	100	SL	50	% v/v	gal/a	POST	37.00 b	78.8 bc	61.3 bc
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST			
5	VINEGAR (20%) (70 GPA)	100	SL	67	% v/v	gal/a	POST	36.40 b	86.3 ab	82.5 ab
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST			
6	MATRAN EC (5%) (35 GPA)	100	EC	5	% v/v	gal/a	POST	59.40 b	68.8 c	37.5 d
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST			
7	MATRAN EC (10%) (35 GPA)	100	EC	10	% v/v	gal/a	POST	41.80 b	70.0 c	47.5 cd
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST			
8	MATRAN EC (15%) (35 GPA)	100	EC	15	% v/v	gal/a	POST	59.15 b	77.5 bc	50.0 cd
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST			
9	MATRAN EC (20%) (35 GPA)	100	EC	20	% v/v	gal/a	POST	34.75 b	78.8 bc	68.8 abc
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST			
10	RACER (70 GPA)	100	SL	6.5	% v/v	gal/a	POST	53.40 b	81.3 bc	91.3 a
11	RACER (35 GPA)	100	SL	13	% v/v	gal/a	POST	50.70 b	93.8 a	92.5 a
12	GREENMATCH EX (70 GPA)	100	SL	10	% v/v	gal/a	POST	70.30 b	70.0 c	70.0 abc
	NUFILM P	100	SL	0.25	% v/v	fl oz/a	POST			
LSD (P=.05)								22.157	9.35	17.60
Standard Deviation								15.345	6.47	12.19
CV								26.99	9.47	22.68

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Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Other Rate Unit	Appl Description	7	8	9	10
Pest Code								SINAL	SINAL	SETFA	SETFA
Pest Name								Yellow mustard	Yellow mustard	Giant foxtail	Giant foxtail
Rating Date								7/25/2008	7/25/2008	7/16/2008	7/25/2008
Rating Type								WEIFRE	WEIDRY	CONTRO	CONTRO
Rating Unit								g/m2	g/m2	%	%
1	UNTREATED						POST	454.40 a	85.80 a	0.0 f	0.0 e
2	VINEGAR (5%) (70 GPA)	100	SL	17	% v/v	gal/a	POST	238.55 bc	41.90 bc	5.0 f	0.0 e
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST				
3	VINEGAR (10%) (70 GPA)	100	SL	33	% v/v	gal/a	POST	152.60 bc	19.60 bc	21.3 de	0.0 e
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST				
4	VINEGAR (15%) (70 GPA)	100	SL	50	% v/v	gal/a	POST	305.25 b	53.25 b	32.5 cde	2.5 e
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST				
5	VINEGAR (20%) (70 GPA)	100	SL	67	% v/v	gal/a	POST	96.20 c	16.00 c	33.8 cd	25.0 d
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST				
6	MATRAN EC (5%) (35 GPA)	100	EC	5	% v/v	gal/a	POST	217.40 bc	37.80 bc	17.5 e	5.0 e
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST				
7	MATRAN EC (10%) (35 GPA)	100	EC	10	% v/v	gal/a	POST	155.40 bc	27.00 bc	30.0 cde	10.0 de
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST				
8	MATRAN EC (15%) (35 GPA)	100	EC	15	% v/v	gal/a	POST	230.50 bc	41.70 bc	23.8 de	15.0 de
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST				
9	MATRAN EC (20%) (35 GPA)	100	EC	20	% v/v	gal/a	POST	154.75 bc	28.75 bc	25.0 de	21.3 d
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST				
10	RACER (70 GPA)	100	SL	6.5	% v/v	gal/a	POST	133.20 bc	21.20 bc	57.5 b	65.0 b
11	RACER (35 GPA)	100	SL	13	% v/v	gal/a	POST	69.10 c	10.70 c	81.3 a	85.0 a
12	GREENMATCH EX (70 GPA)	100	SL	10	% v/v	gal/a	POST	107.15 c	20.00 bc	40.0 c	41.3 c
	NUFILM P	100	SL	0.25	% v/v	fl oz/a	POST				
LSD (P=.05)								115.627	22.083	10.31	11.61
Standard Deviation								80.079	15.294	7.14	8.04
CV								41.52	45.46	23.31	35.73

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The Pennsylvania State University

Pest Code								ABUTH	ABUTH	CHEAL
Pest Name								Velvetleaf	Velvetleaf	Common lambsqu>
Rating Date								7/16/2008	7/25/2008	7/16/2008
Rating Type								CONTRO	CONTRO	CONTRO
Rating Unit								%	%	%
Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Other Rate Unit	Appl Description	11	12	13
1	UNTREATED						POST	0.0 f	0.0 d	0.0 g
2	VINEGAR (5%) (70 GPA)	100	SL	17	% v/v	gal/a	POST	8.8 ef	0.0 d	7.5 g
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST			
3	VINEGAR (10%) (70 GPA)	100	SL	33	% v/v	gal/a	POST	31.3 cd	1.3 d	20.0 f
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST			
4	VINEGAR (15%) (70 GPA)	100	SL	50	% v/v	gal/a	POST	33.8 cd	8.8 cd	51.3 e
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST			
5	VINEGAR (20%) (70 GPA)	100	SL	67	% v/v	gal/a	POST	60.0 ab	28.8 b	88.8 ab
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST			
6	MATRAN EC (5%) (35 GPA)	100	EC	5	% v/v	gal/a	POST	20.0 de	0.0 d	65.0 d
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST			
7	MATRAN EC (10%) (35 GPA)	100	EC	10	% v/v	gal/a	POST	42.5 bc	13.8 bcd	83.8 ab
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST			
8	MATRAN EC (15%) (35 GPA)	100	EC	15	% v/v	gal/a	POST	42.5 bc	15.0 bcd	78.8 bc
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST			
9	MATRAN EC (20%) (35 GPA)	100	EC	20	% v/v	gal/a	POST	45.0 bc	23.8 bc	90.0 ab
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST			
10	RACER (70 GPA)	100	SL	6.5	% v/v	gal/a	POST	56.3 ab	55.0 a	86.3 ab
11	RACER (35 GPA)	100	SL	13	% v/v	gal/a	POST	67.5 a	55.0 a	93.8 a
12	GREENMATCH EX (70 GPA)	100	SL	10	% v/v	gal/a	POST	42.5 bc	41.3 a	73.8 c
	NUFILM P	100	SL	0.25	% v/v	fl oz/a	POST			
LSD (P=.05)								13.65	11.77	7.97
Standard Deviation								9.45	8.15	5.52
CV								25.21	40.35	8.96

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The Pennsylvania State University

Pest Code								CHEAL	AMACH	AMACH
Pest Name								Common lambsqu>	Smooth pigweed	Smooth pigweed
Rating Date								7/25/2008	7/16/2008	7/25/2008
Rating Type								CONTRO	CONTRO	CONTRO
Rating Unit								%	%	%
Trt No.	Treatment Name	Form Conc	Form Type	Rate	Rate Unit	Other Rate Unit	Appl Description	14	15	16
1	UNTREATED						POST	0.0 e	0.0 g	0.0 d
2	VINEGAR (5%) (70 GPA)	100	SL	17	% v/v	gal/a	POST	0.0 e	5.0 g	0.0 d
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST			
3	VINEGAR (10%) (70 GPA)	100	SL	33	% v/v	gal/a	POST	13.8 e	18.8 f	20.0 c
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST			
4	VINEGAR (15%) (70 GPA)	100	SL	50	% v/v	gal/a	POST	50.0 cd	53.8 e	45.0 b
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST			
5	VINEGAR (20%) (70 GPA)	100	SL	67	% v/v	gal/a	POST	80.0 ab	92.5 a	77.5 a
	NATURAL WET	100	SL	0.1	% v/v	fl oz/a	POST			
6	MATRAN EC (5%) (35 GPA)	100	EC	5	% v/v	gal/a	POST	35.0 d	66.3 d	43.8 b
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST			
7	MATRAN EC (10%) (35 GPA)	100	EC	10	% v/v	gal/a	POST	46.3 cd	75.0 bcd	43.8 b
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST			
8	MATRAN EC (15%) (35 GPA)	100	EC	15	% v/v	gal/a	POST	52.5 cd	70.0 cd	42.5 b
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST			
9	MATRAN EC (20%) (35 GPA)	100	EC	20	% v/v	gal/a	POST	88.8 a	83.8 abc	60.0 ab
	HUMASOL	100	SL	2.5	% v/v	qt/a	POST			
10	RACER (70 GPA)	100	SL	6.5	% v/v	gal/a	POST	88.8 a	85.0 abc	73.8 a
11	RACER (35 GPA)	100	SL	13	% v/v	gal/a	POST	92.5 a	88.8 ab	72.5 a
12	GREENMATCH EX (70 GPA)	100	SL	10	% v/v	gal/a	POST	63.8 bc	78.8 a-d	61.3 ab
	NUFILM P	100	SL	0.25	% v/v	fl oz/a	POST			
LSD (P=.05)								16.69	11.50	13.40
Standard Deviation								11.56	7.97	9.28
CV								22.69	13.32	20.62

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EXHIBIT I

An Efficacy Trial of Potential Herbicides for Use in Organic Systems.

Jeff J. Gunderson, Patrick M. Carr and Timothy Winch
North Dakota State University Dickinson Research Extension Center

SUMMARY

Non-synthetic herbicides are herbicides utilizing naturally-occurring active ingredients for weed control. Under the National Organic Program, a small number of these herbicides have been approved for application on certified organic crop land (USDA AMS, 2002). These herbicides may provide an important tool for weed control in organic systems, if they prove effective. This study was concerned with evaluating the efficacy of three of these weed control products and to establish recommended rates for these products.

The three weed control products evaluated were corn gluten meal, vinegar and Racer. Corn gluten meal (CGM) has been shown to reduce germination of small-seeded weeds (Liu & Christians, 1996; Boydston et al., 2008), while vinegar (20% acetic acid) and Racer™ (ammonium nonanoate), have potential as burn down herbicides (Radhakrishnan et al., 2003; Webber III et al., 2008). All products were applied pre-plant and plots were subsequently seeded to pea. Grass weed abundance in pea was not affected by any of the products, while Racer reduced overall weed biomass according to visual evaluation and reduced broadleaf weed biomass compared to CGM.

INTRODUCTION

The National Organic Program, and most organic grower groups, place emphasis on preventative and cultural measures for weed control. These measures are an important component of a weed control strategy and can be effective in reducing severe weed problems, but in most cases weed control will still be necessary at some point during the growing season. Tillage is relied on heavily for weed control in many organic cropping systems, and can be an effective method of eliminating weeds. However, it is well known that excessive tillage can lead to problems with soil erosion and can negatively impact soil structure, organic matter content and humus formation. Furthermore, tillage can reduce soil water retention in comparison with no-till management, a fact that could have significant implications in low-rainfall, drought prone regions (Franzluebbers, 2004). Having a burn-down herbicide option could provide organic growers, especially those in dryland regions, with a useful tool for pre-emergence weed control that retains the benefits of minimized soil disturbance. A few herbicides are registered for use under the National Organic Standards, and therefore available to organic growers, although none of these products are presently labeled for use in North Dakota. These herbicides utilize naturally-occurring substances for weed control, such as clove and garlic oils, soap salts or acids, but little research has been conducted evaluating their efficacy.

Three non-synthetic, "natural" products were evaluated for their ability to control weeds in field pea. Racer™ bio-herbicide (Falcon Labs LLC, Wilmington, DE) Nature's Guide® Vinegar (Harvest Supply Company, Fort Worth, TX) and Nature's Guide® Corn Gluten Meal (Harvest Supply Company, Fort Worth, TX). The active ingredient in Racer is ammonium nonanoate (40%), a soap salt. Soap salts reduce the surface tension of water and lead to the collapse of guard cells around the stomata. As a result, the stomata become clogged and gas exchange is unable to occur, killing the plant (Ware and Whiteacre, 2004). Racer is a non-selective burndown herbicide. Vinegar containing high levels of acetic acid, well above the 5% acetic acid concentration of household vinegar, also has potential as a non-selective herbicide. Acetic acid works as a herbicide by causing the dissolution of cell membranes and the desiccation of the plant. Corn gluten meal is a byproduct of corn processing that has shown potential as a germination inhibitor of small-seeded plant species in research trials.

MATERIALS AND METHODS

The three products were all applied pre-plant. Treatments covered in this report include CGM at a rate of approximately 2.15 tn/ac, Racer at a rate of 14.4 lb ai/ac and Vinegar (20% acetic acid) at a rate of 35 gallons/acre. Corn gluten meal (CGM) was applied on May 20, Racer and Vinegar on May 27 and field pea was seeded on May 28. A weed-free and a weedy check treatment were included. Weed control was evaluated visually 1, 7, 14 and 21 days after treatment (DAT) and was reported as % control. Crop and weed biomass samples were taken on July 23 in all treatments except the weed free check, in which biomass samples were taken on August 5.

RESULTS

Visual assessments indicated a significantly greater overall control of weeds by Racer compared to CGM 1 DAT and compared to CGM and vinegar 7 DAT (Table 1). No significant difference in % control was observed at 14 or 21 DAT. Even though Racer application initially resulted in greater weed control, at most control was only 10.75%, which occurred 1 DAT.

Crop and weed biomass sampling indicated that CGM produced the least control of broadleaf weeds (Fig. 1). Racer suppressed broadleaf weed biomass compared with CGM and weedy check plots, but field pea growth was reduced in plots where Racer was applied compared with weed-free (hand-weeded) plots. The reduced pea growth in Racer plots compared with weed-free plots probably reflects greater competition from weeds in the Racer plots, even though no difference in broadleaf weed biomass was detected statistically between the Racer treatment (weed biomass ≈ 793 lb/acre) and the weed-free treatment (weed biomass ≈ 24 lb/ac). We were unable to detect any difference in broadleaf weed growth between plots where vinegar or CGM was applied and plots where no weed control was attempted. Grass weeds were low in abundance and showed to no response to treatment effects.

Table 1. Mean % weed control by three non-synthetic products based on visual assessment up to 3 weeks after treatment.

Product	Rate	1 DAT	7 DAT	14 DAT	21 DAT
		% Control			
CGM	2.15 tn/ac	0.00	1.00	0.00	0.00
Racer	14.4 lb ai/ac	10.75	4.50	3.75	2.50
Vinegar	35 gal/ac	5.25	0.00	0.00	0.00
LSD α=0.05		7.38	1.55	NS	NS
P		0.0359	0.0001	0.1757	0.4393

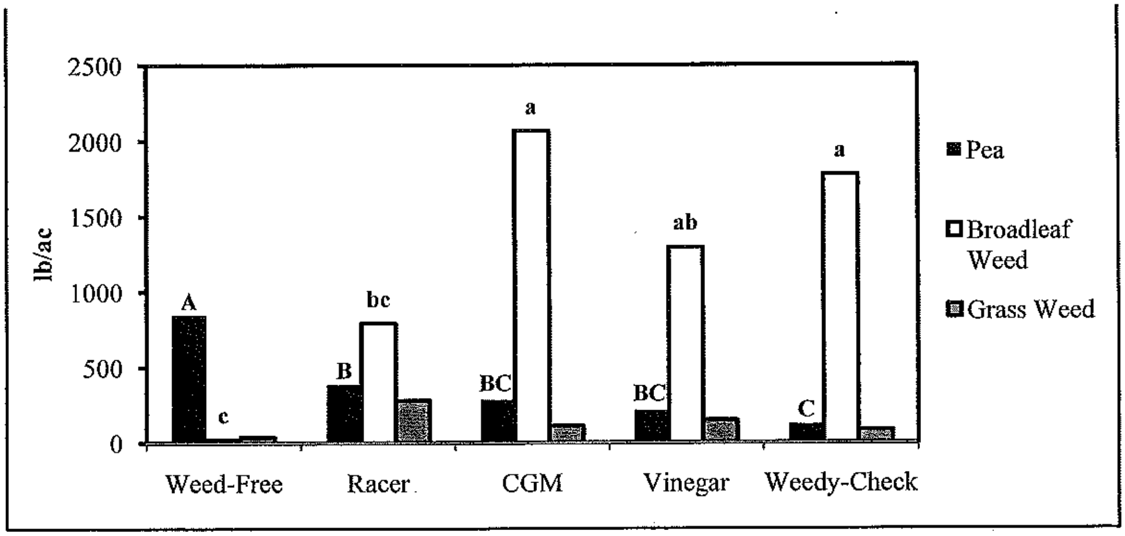

Figure 1. Average weed and crop biomass at harvest as affected by potential organic herbicides. Different uppercase letters denote significant between treatment differences in field pea biomass. Different lowercase letters denote significant between treatment differences in broadleaf weed biomass.

LITERATURE CITED

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USDA ars United States Department Of Agriculture
Agricultural Research Service

Research Project: YIELD AND QUALITY OF VEGETABLE CROPS IN CONVENTIONAL AND ORGANIC PRODUCTION SYSTEMS

EXHIBIT J

Location: Lane, OK

Title: Ammonium pelargonate as a potential organic herbicide

Authors

- Webber, Charles
- Brandenberger, Lynn - OSU, STILLWATER, OK
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- Wells, Lynda - OSU, STILLWATER, OK
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Submitted to: Proceedings of Southern Weed Science Society
Publication Type: Abstract
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Publication Date: June 17, 2008
Citation: Webber III, C.L., Brandenberger, L.P., Shrefler, J.W., Wells, L.K., Shannon, K. 2008. Ammonium pelargonate as a potential organic herbicide [abstract]. 2008 Proceeding, Southern Weed Science Society, January 28-30, 2008, Jacksonville, Florida. 61:136.

chnical Abstract: Weed control is a serious concern for commercial vegetable producers because of the limited number of herbicides available for this group of minor crops and the potential for crop injury. Organic producers of vegetables have an even greater challenge since their weed control tools are limited to cultural methods exclusively. Racer (40% ammonium pelargonate/ammonium nonanoate) is labeled for non-food use and efforts are currently underway to label it as a bio-herbicide for organically grown food crops. The main component of Racer is ammonium pelargonate which occurs in nature and is primarily formed from biodegradation of higher fatty acids. The objective of this study was to investigate impact of application rates and volumes on the weed control efficacy of Racer on endemic weed populations. The field experiment was conducted on fine sandy loam at Lane, OK. The experiment consisted of 9 weed control treatments, which included 2 herbicide rates (7.2 and 10.8 kg/ha) applied at 4 application volumes (164, 327, 655, and 982 L/ha), plus an untreated weedy-check. Racer was applied as a broadcast application using a tractor mounted CO**2 sprayer equipped with four extended range, stainless steel, 1.14 L/min nozzles, on 0.5-m spacings at a spraying height of 0.5 m. To maintain the same spray pattern for each weed control treatment, nozzle pressure was held constant and tractor speed adjusted to achieve the different overall application rates (164, 327, 655, and 982 L/ha). At the time of spraying tumble (Amaranthus albus L.) and spiny (Amaranthus spinosus L.) pigweed were 2.5-3.8 cm tall, carpetweeds (Mollugo verticillata L.) were 2.5 cm across, and grasses, goosegrass (Eleusine indica L. Gaertn.) and smooth crabgrass [Digitaria isahaemum (Schreb. ex Schweig) Schreb. Ex Muhl.] leaves were 5.1-7.6 cm long. Weeds were rated 6 days after treatment for percent weed control. In general, application of Racer produced greater weed control for the broadleaf weed species (tumble pigweed, spiny pigweed, and carpetweed) than the grass weeds (goosegrass and smooth crabgrass). Although all Racer applications produced significantly greater weed control for all weed species compared to the weedy-check, there were no significant differences among er applications for grass weed control. Grass weed control ranged from 30 to 52.5% for goosegrass d 22.5 to 52.50% for smooth crabgrass. The range and magnitude of the broadleaf weed control was much greater than the grass weed control. The best weed control for both pigweed species occurred at the 10.8 kg/ha rate applied at 655 L/ha. Carpetweed was very sensitive to Racer, producing 65% weed control at the lowest application rate and volume, and most application rates and volumes producing at

least 85% control. The factorial analysis determined that there were no significant differences among application volumes when averaged across the herbicide application rates. Although not significantly different, there was a tendency for pigweed control to be maximized at the 655 L/ha application volume. Weed control for all weed species was significantly greater for the 10.8 kg/ha application rate compared to the 7.2 kg/ha. Whether comparing the impact of application volume (164, 327, 655, and 982 L/ha) or application rates (7.2 and 10.8 kg/ha), weed control was the greatest for carpetweed compared to either the pigweeds or grass weeds. These results indicate that Racer has an excellent potential as an effective organic herbicide if it achieves the proper clearance. As with other contact herbicides, organic and non-organic, Racer provided greater weed control for broadleaf weeds than grass weeds. It is also important to note that Racer provided consistent control across a large range of application volumes.

Last Modified: 10/06/2009

UNITED STATES DEPARTMENT OF LABOR

OCCUPATIONAL SAFETY & HEALTH ADMINISTRATION

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<< Chemical Sampling Information (CSI)

Printing Instruction:

Chemical Sampling Information

Acetic acid

01-06-10A08:06 CFMD

General Description

Synonyms: Acetic acid (aqueous); Ethanoic acid; Glacial acetic acid (pure compound); Methanecarboxylic acid [Note: Can be found in concentrations of 5-8% in vinegar.]

OSHA IMIS Code Number: 0020

Chemical Abstracts Service (CAS) Registry Number: 64-19-7

NIOSH, Registry of Toxic Effects (RTECS) Identification Number: AF1225000

Department of Transportation Regulation Number (49 CFR 172.101): 2790 153 [27 KB, PDF] (10-80% acid); 2789 132 [27 KB, PDF] (>80% acid)

NIOSH Pocket Guide to Chemical Hazards, Acetic acid: chemical description, physical properties, potentially hazardous incompatibilities, and more

Quick Links

- General Description
- Exposure Limits
- Health Factors
- Monitoring

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O P Q R S T U V W X Y Z

By *CAS Number*

Exposure Limits

OSHA Permissible Exposure Limit (PEL) for General Industry: 29 CFR 1910.1000 Z-1 Table -- 10 ppm, 25 mg/m^3 TWA

OSHA Permissible Exposure Limit (PEL) for Construction Industry: 29 CFR 1926.55 Appendix A -- 10 ppm, 25 mg/m^3 TWA

OSHA Permissible Exposure Limit (PEL) for Maritime: 29 CFR 1915.1000 Table Z-Shipyards -- 10 ppm, 25 mg/m^3 TWA

American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV): 10 ppm, 25 mg/m^3 TWA; 15 ppm, 37 mg/m^3 STEL

National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL): 10 ppm, 25 mg/m^3 TWA; 15 ppm, 37 mg/m^3 STEL

Health Factors

NIOSH Immediately Dangerous To Life or Health Concentration (IDLH): 50 ppm

Potential symptoms: Irritation of eyes, skin; nose, throat; cough, sore throat, eye, skin burns; blisters, skin sensitization; dental erosion; black skin, hyperkeratosis; conjunctivitis, lacrimation; headache, dizziness shortness of breath, pharyngeal edema; chronic bronchitis; pulmonary edema (may be delayed); loss of vision; INGES. ACUTE: Abdominal pain, burning sensation, vomiting, diarrhea; hemolysis, hemoglobinuria, kidney failure; shock or collapse.

Health Effects: Irritation- Eye, Nose, Throat, Skin---Marked (HE14) Asthma (HE9), Lung damage (HE10, HE11).

Affected organs: Eyes, skin, respiratory system, teeth

Notes:

1. Vapor/air mixtures of acetic acid may be explosive at temperatures above 39°C.
2. Acetic acid is listed by the FDA as a direct food substance affirmed as generally recognized as safe (GRAS) (21 CFR 184.1005).
3. Five cases of occupational asthma with chronic rhinitis and sinusitis were reported among employees ir a vegetable pickling plant where the mean acetic acid concentration in 10 workroom air samples was 12.2 ppm. Non-smokers (n=74) also had significantly increased incidences of dyspnea, hoarseness, and headache than did smokers (n=29) at this plant.
4. Acetic acid is one of the VOCs found in both liquid and paste forms of butter flavoring used in microwave popcorn production plants. In one of these plants where severe lung disease was found in 9 former employees, NIOSH found a mean acetic acid concentration of 5.5 ppm (n=8), with a top measurement of 12.4 ppm, in the mixing area and a mean of 2.7 ppm (n=24) in the microwave packaging area.
5. Protracted airway hyperresponsiveness and symptoms of chest tightness, coughing, and shortness of breath were described in several hospital employees after acute exposure to vapors from a gallon of glacial acetic acid that was spilled on a floor.
6. The release of acetic acid during the curing of some silicone sealers is thought to be related to the severity of dental erosion in those who work with silicone.

Date Last Revised: 03/22/2007

Literature Basis:

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Monitoring Methods used by OSHA

Laboratory Sampling/Analytical Method:

- **sampling media:** Charcoal Tube (100/50 mg sections)
  analytical solvent: 0.01 N NaOH
  maximum volume: 48 Liters **maximum flow rate:** 0.2 L/min
  current analytical method: Ion Chromatography; IC
  method reference: OSHA Analytical Method (OSHA PV2119)
  method classification: Partially Validated

On-Site Sampling Techniques/Methods:

- **device:** Detector Tube
  manufacturer: Gastec
  model/type: 81
  sampling information: 0.5 to 2 strokes
  upper measurement limit: 100 ppm
  detection limit: 0.2 ppm
  overall uncertainty: 10% for 2 to 10 ppm, 5% for 10 to 50 ppm
  method reference: on-site air secondary (SEI Certified)

- **device:** Detector Tube
  manufacturer: Matheson-Kitagawa
  model/type: 8014-216S
  sampling information: follow manufacturer's instructions
  upper measurement limit: 50 ppm
  detection limit: 1 ppm
  overall uncertainty: unknown
  method reference: on-site air secondary (SEI Certified)

Wipe Sampling Method:

- **sampling media:** Whatman smear tab
  analytical solvent: Deionized Water

Ac ibility Assistance: Contact the OSHA Directorate of Science, Technology and Medicine at 202-693-2300 for assistance accessing PDF materials.

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Occupational Safety & Health Administration
200 Constitution Avenue, NW
Washington, DC 20210

Page last updated: 12/12/2007

NIOSH Publication 2005-149
September 200

NIOSH Pocket Guide to Chemical Hazards

Acetic acid

CAS 64-19-7

CH_3COOH

RTECS AF1225000

Synonyms & Trade Names

Acetic acid (aqueous), Ethanoic acid, Glacial acetic acid (pure compound), Methanecarboxylic acid [Note: Can be found in concentrations of 5-8% in vinegar.]

DOT ID & Guide

2790 153 (10-80% acid)
2789 132 (>80% acid)

Exposure Limits

NIOSH REL: TWA 10 ppm (25 mg/m^3) ST 15 ppm (37 mg/m^3)

OSHA PEL: TWA 10 ppm (25 mg/m^3)

IDLH 50 ppm See: 64197

Conversion 1 ppm = 2.46 mg/m^3

Physical Description

Colorless liquid or crystals with a sour, vinegar-like odor. [Note: Pure compound is a solid below 62°F. Often used in an aqueous solution.]

MW: 60.1	BP: 244°F	FRZ: 62°F	Sol: Miscible
VP: 11 mmHg	IP: 10.66 eV		Sp.Gr: 1.05
Fl.P: 103°F	UEL(200°F): 19.9%	LEL: 4.0%	

Class II Combustible Liquid: Fl.P. at or above 100°F and below 140°F.

Incompatibilities & Reactivities

Strong oxidizers (especially chromic acid, sodium peroxide & nitric acid), strong caustics [Note: Corrosive to metals.]

Measurement Methods

NIOSH 1603; OSHA ID186SG
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection codes)

Skin: Prevent skin contact (>10%)
Eyes: Prevent eye contact
Wash skin: When contaminated (>10%)
Remove: When wet or contaminated (>10%)
Change: No recommendation
Provide: Eyewash (>5%), Quick drench (>50%)

First Aid (See procedures)

Eye: Irrigate immediately
Skin: Water flush immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH/OSHA

Up to 50 ppm:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode£
(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)£
(APF = 50) Any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece
Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure

mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape:

(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus

ortant additional information about respirator selection

Exposure Routes inhalation, skin and/or eye contact

Symptoms Irritation eyes, skin, nose, throat; eye, skin burns; skin sensitization; dental erosion; black skin, hyperkeratosis; conjunctivitis, lacrimation (discharge of tears); pharyngeal edema, chronic bronchitis

Target Organs Eyes, skin, respiratory system, teeth

See also: INTRODUCTION See ICSC CARD: 0363

EXHIBIT L

US Environmental Protection Agency
Office of Pesticide Programs

BIOPESTICIDES REGISTRATION ACTION DOCUMENT

AMMONIUM NONANOATE (PC code 031802)

BIOPESTICIDE REGISTRATION ACTION DOCUMENT

AMMONIUM NONANOATE

(PC code 031802)

U.S. Environmental Protection Agency
Office of Pesticide Programs
Biopesticides and Pollution Prevention Division

Ammonium nonanoate
(PC Code 031802)

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Denise Greenway
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I. EXECUTIVE SUMMARY

A. IDENTITY

The new active ingredient ammonium nonanoate, is a C_9 saturated-chain fatty acid soap salt. The end use product contains 40.0% by weight ammonium nonanoate. The product chemistry data submitted by the registrant satisfies the requirements for product identity.

B. USE/USAGE

Ammonium nonanoate will be used for the suppression and control of a wide variety of weeds including: grasses, vines, and brush (non-food uses)..

C. RISK ASSESSMENT

Ammonium nonanoate is closely related to other salts of fatty acids known as soap salts. Toxicology and environmental data requirements for this biochemical herbicide product were waived, primarily via the Agency's Reregistration Eligibility Document (RED) for Soap Salts. The RED (EPA-738-F-92-013, September, 1992) concludes that no risks to human health are expected from the use of ammonium salts of higher fatty acids (C_8-C_{18} saturated and C_{18} unsaturated) based on their low toxicity and the fact that residues from pesticide uses are not likely to exceed the levels of naturally-occurring or intentionally-added fatty acids in commonly-eaten foods. Ammonium salts of fatty acids are rapidly biodegraded in the environment, and are expected to be only minimally toxic to nontarget organisms, with the exception of aquatic invertebrates. Appropriate precautionary labeling of end use products containing ammonium salt will further minimize potential exposure and mitigate risk to humans and nontarget organisms.

The Agency has considered ammonium nonanoate in light of relevant safety factors in the Food Quality Protection Act (FQPA) of 1996 and under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and determined there will be no unreasonable adverse effects from the use of this product. The Agency has considered available data and other factors, including the natural occurrence of soap salts, their common use as food items, and the lack of reported adverse effects, and believes that end use products containing ammonium nonanoate, can be used without causing unreasonable adverse effects to humans or the environment.

D. DATA GAPS / LABELING RESTRICTIONS

There are no data gaps. This active ingredient is toxic to fish and aquatic invertebrates and should not be applied directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark.

II. OVERVIEW

A. ACTIVE INGREDIENT OVERVIEW

Common Name:	Ammonium nonanoate Ammonium pelargonate Pelargonic acid, ammonium salt Nonanoic acid, ammonium salt
Chemical Name:	Octane-1-carboxylic acid, ammonium salt
Chemical Formula:	$[C_9\text{-}H_{18}\text{-}O_2]\text{-}NH_4$
Chemical Family:	Ammonium salt of fatty acids C8-C18
Trade and Other Names:	Racer™ Concentrate
CAS Registry Number:	63718-65-0
OPP Chemical Code:	031082
Basic Manufacturer:	Falcon Lab, LLC 1103 Norbee Drive Wilmington, DE 19803

B. USE PROFILE

The following is information on the proposed uses with an overview of use sites and application methods.

Type of Pesticide: Non-systemic, broad-spectrum contact herbicide.

Use Sites: **Ammonium nonanoate can not be used on or around food crops**. Ammonium nonanoate is to be used for the suppression and control of weeds, vines, and underbrush by home owners, master gardeners, farmers, landscape and turf professionals, and interior scapers. It may be used in nurseries, greenhouses, and lath or shade houses.

Target Pests: Weeds including: grasses, vines, underbrush, annual/perennial plants, including moss, saplings, and tree suckers.

Formulation Type: Liquid

Method and Rates of Application: Ammonium nonanoate can be applied using standard spary methods of liquid herbicide application, including hand-held, boom, pressure, and hose-end sprayers. For use, the concentrate is diluted with water to the desired concentration. Application rates are up to a maximum concentration of 6.0 % by weight (corresponding to 2.4% by weight ammonium nonanoate) in water. For the product to be effective, the leaves of undesirable vegetation must by uniformly sprayed and thoroughly wetted. Application can be repeated as often as necessary to obtain the desired control.

***Use Practice Limitations*:** Ammonium nonanoate can not be used on or around food crops.

C. ESTIMATED USAGE

None used yet since this will be the first registration of this active ingredient.

D. DATA REQUIREMENTS

The Agency granted the registrant's request for waivers from the requirements of studies/data for acute mammalian toxicity and for certain non-target organism testing. These data were waived primarily based on information in the Agency's published RED for Soap Salts (EPA-738-F-92-013, September, 1992), including the natural occurrence of soap salts, their common use or in food items, a lack of reported adverse effects, no expected risk to human health, and no expected adverse effects to nontarget organisms when the end use product is used as directed.

Product analysis data requirements for the end use product were adequately satisfied.

The data required for granting this registration under Section 3(c)(5) of FIFRA have been reviewed by the Biopesticides and Pollution Prevention Division (BPPD). Based on the submitted information, the Agency foresees no unreasonable adverse effects to human health and the environment from the use of ammonium nonanoate as long as it is used as labeled.

E. REGULATORY HISTORY

On **August 18, 2005**, the Agency received an application from Falcon Lab LLC, to register an ammonium nonanoate product, containing 40.0% by weight active ingredient. A notice of receipt of the application for registration of ammonium nonanoate as a new active ingredient for end use products to control unwanted vegetation was published in the Federal Register on November 23, 2005.

F. CLASSIFICATION

Ammonium nonanoate, is a C_9 saturated-chain fatty acid soap salt, and is classified as a biochemical pesticide.

G. FOOD CLEARANCES/TOLERANCES

A Proposed Rule was published on May 1, 1996 (61FR 19233-36) to exempt ammonium salts of fatty acids and related C_8-C_{18} fatty acids ammonium salts from the requirement of a tolerance for residues in or on all raw agricultural commodities when used in accordance with good agricultural practice; however, the proposed rule was never finalized by the Agency.

III. SCIENCE ASSESSMENT

A. PHYSICAL/CHEMICAL PROPERTIES ASSESSMENT

All product chemistry data requirements for ammonium nonanoate are satisfied.

1. Product Identity and Mode of Action:

a. **Product Identity:** The new active ingredient, ammonium nonanoate, is a C_9 saturated-chain fatty acid soap salt. It represents 40.0% by weight of the end use product is 40% by weight of ammonium nonanoate, which is a clear, colorless to pale yellow liquid with a slight fatty acid odor.

b. **Mode of Action:** Ammonium nonanoate is a non-systemic, broad-spectrum contact herbicide that has no soil activity.

2. **Physical and Chemical Properties Assessment:** The physical and chemical characteristics of ammonium nonanoate were submitted to support its registration. These are summarized in Table 1.

TABLE 1. Product chemistry data requirements

Guideline No.	Study	Results	MRID No.
151-10 (OPPTS 880.1100)	Product identity	The submitted data satisfy the requirements for product identity.	46640401
151-11 (OPPTS 880.1200)	Manufacturing process	The submitted data satisfy the requirements for the manufacturing process	46640401
151-12 (OPPTS 880.1400)	Discussion of formation of unintentional ingredients	The submitted data satisfy the requirements for the discussion of the formation of unintentional ingredients.	46640401
151-13 (OPPTS 830.1700)	Analysis of samples	The submitted data satisfy the requirements for the analysis of samples.	46640401
151-15 (OPPTS 830.1750)	Certification of limits	The submitted data satisfy the requirements for the certification of limits.	46640401
151-16 (OPPTS 830.1800)	Analytical method	An acceptable analytical method was submitted.	46640401
Physical/chemical Properties for the EP			
63-2 (OPPTS 830.6302)	Color	Clear, colorless to pale yellow @ 20°C	46640402
63-3 (OPPTS 830.6303)	Physical State	Liquid @ 20°C	46640402
63-4			

(OPPTS 830.6304)	Odor	Slightly fatty acid odor @ 20°C	46640402
63-5 (OPPTS 830.7200)	Melting point	Not required for EP	
63-6 (OPPTS 830.7220)	Boiling point	Not required for EP	
63-7 (OPPTS 830.7300)	Density	Specific gravity = 1.00 ± 0.00 @ 20°C	46640402
63-8 (OPPTS 830.7840)	Solubility	Not required for EP	
63-9 (OPPTS 830.7950)	Vapor Pressure	17.5 mm Hg at 20 °C 23.8 mm Hg at 25 °C	
63-10 (OPPTS 830.7370)	Dissociation Constant	Not required for EP	
63-11 (OPPTS 830.7550)	Octanol/water partition coefficient	Not required for EP	46640402
63-12 (OPPTS 830.7000)	pH	7.5 ± 0.5 @ 24.0°C	
63-13 (OPPTS 830.6313)	Stability	Long history of stability of fatty acid soap salts in plastic containers in the form of detergents.	
63-14 (OPPTS 830.6314)	Oxidation/reduction	Not Applicable	
63-15 (OPPTS 830.6315)	Flammability	Product is non-flammable	46640402
63-16 (OPPTS 830.6316)	Explodability	Product is non-explodable (no known explosion characteristics)	46640402
63-17 (OPPTS 830.6317)	Storage stability	Waiver requested; product consists of a soap salt of a fatty acid or a soap solution that has for several decades been routinely packaged in plastic containers and remains stable for longer than 24 months.	46640402
63-18 (OPPTS 830.7100)	Viscosity	61.02 ± 0.01 cP	46640402
63-19 (OPPTS 830.6319)	Miscibility	Completely miscible in water	46640402
63-20 (OPPTS 830.6320)	Corrosion characteristics	Not corrosive; product consists of a soap salt of a fatty acid or a soap solution that has for several decades been routinely packaged in plastic containers without exhibiting corrosive properties.	46640402
63-21 (OPPTS 830.6321)	Dielectric breakdown voltage	Not applicable, not for use in/around electrical equipment.	46640402

B. HUMAN HEALTH ASSESSMENT

1. Toxicology Assessment

The active ingredient, ammonium nonanoate, is a C_9 saturated-chain fatty acid soap salt. The Agency RED for Soap Salts (EPA-738-F-92-013, September, 1992) treats all ammonium salts of higher fatty acids (C_8-C_{18} saturated and C_{18} unsaturated) as one active ingredient. The registrant requested waivers for the acute toxicology data requirements listed in Table 2, based on the assessment in the RED that all toxicity data requirements for active ingredients of soap salts have been fulfilled.

According to the RED, oral exposure to soaps is generally self-limiting, since the taste of soap is easily recognized and is unpleasant. In addition, ammonium soap salts have an ammonia odor that is limiting. Soap salts are of low acute toxicity when taken orally, and have been placed in Toxicity Category IV.

The RED states that soap salts are also placed in Toxicity Category IV for acute dermal toxicity. When applied to skin for longer periods of time (24 hours), soap salts can produce mild to moderate irritation. Ammonium soaps of higher fatty acids may also cause allergic skin reactions in some individuals, but the Agency believes allergic reactions are uncommon and transient. Soap salts are not classified as skin sensitizers.

Ammonium soap salts are irritating to the eyes, and can cause permanent eye damage.

A published data summary submitted by the registrant (IUCLID, 2000, cited in HERA, 2002) states that very limited data exist on the effects of acute inhalation of fatty acids or their salts. This is to be expected, since in normal use scenarios the primary route of exposure would be dermal. The only inhalation study cited in the submitted summary was one in which no deaths were seen in 10 rats exposed for eight hours to saturated vapors of mixed isomers of decanoic acid.

The RED states that DNA inhibition was reported when guinea pig cells were tested with 600 μmol/L of the sodium salt of caprylic acid. Unscheduled DNA synthesis was found in mouse cells treated with 35 mg/kg of oleic acid. Further, cytogenetic analysis was positive for hamster fibroblasts treated with 2500 μg/L of oleic acid and for *Saccharomyces cerevisiae* treated with 100 mg/L oleic acid. It is highly unlikely that humans would be exposed to soap salts at the doses reported above when the product is used according to label use directions.

Based on the information provided by the registrant, and the conclusion in the soap salts RED that the toxicological data base for ammonium soaps of fatty acid is adequate, the Agency granted the requested waivers for the acute toxicology data requirements (Table 2) .

TABLE 2. Mammalian toxicity data requirements

Guideline No.	Study	Results	MRID No.
152-10 (OPPTS 870.1100)	Acute oral toxicity	Waiver accepted	46640403

152-11 (OPPTS 870.1200)	Acute dermal toxicity	Waiver accepted	46640403
152-12 (OPPTS 870.1300)	Acute inhalation toxicity	Waiver accepted	46640403
152-13 (OPPTS 870.2400)	Primary eye irritation	Waiver accepted	46640403
152-14 (OPPTS 870.2500)	Primary dermal irritation	Waiver accepted	46640403
152-18	Immune response	Waiver accepted	46640403

2. Dose Response Assessment

Based on available information, no toxicity endpoints were identified.

3. Dietary Exposure and Risk Characterization

According to the Soap Salts RED (EPA-738-F-92-013, September, 1992), exposure to low levels of soap salt residues on treated foods poses no known health risks. Soaps are mineral salts of naturally-occurring fatty acids. Fatty acids are a significant part of the normal human daily diet, since they occur in dietary lipids that usually constitute about 90 grams in a day's diet. Residues from pesticide uses of soap salts are not likely to exceed the levels of naturally-occurring fatty acids in commonly eaten foods. FDA lists salts of fatty acids as additives that may be used as binders, emulsifiers, and anti-sticking agents in food (21 CFR 172.863). Additionally, FDA lists oleic acid derived from tall oil fatty acids (21 CFR 172.862) and lists fatty acids, including capric, caprylic, lauric, myristic, oleic, palmitic, and stearic acids, as additives that may be safely used in foods (21 CFR 172.860). Stearic acid is generally recognized as safe (GRAS) for use as an ingredient in food (21 CFR 184.1090). A number of fatty acid salts are approved for uses in food packaging materials (21 CFR 181). Due to the low acute oral and acute dermal toxicity of soap salts, and because residues from pesticide uses are not likely to exceed the levels of naturally-occurring or intentionally added fatty acids in commonly-eaten foods, the Agency believes the risk to consumers from areas treated is negligible. No agricultural crop is to be treated with this active ingredient.

4. Occupational and Residential Exposure

a. **Occupational Exposure and Risk Characterization:** The potential for dermal, eye, and inhalation exposure to the pesticide exists for handlers and applicators. Exposure of applicators can be significant, but soaps generally have low toxicity to humans and there is no reason to expect that the use of ammonium nonanoate in accordance with label directions would constitute any significant hazard. Long-sleeved shirt, chemical-resistant gloves and boots, and protective eyewear are required to mitigate potential exposure. The Agency will require the appropriate signal word and precautionary statements to mitigate any risk from exposure.

b. **Residential, School and Daycare Exposure and Risk Characterization:** Because toxicological endpoints are not expected, risk from the consumption of residues of ammonium nonanoate is not expected for populations in residential, school, and daycare settings.

5. Drinking Water Exposure and Risk Characterization

No significant exposure is expected from an accumulation of ammonium nonanoate in the aquatic environment when it is used according to the precautionary label language. Ammonium nonanoate is not to be applied directly to water, and the RED states that ammonium salts of fatty acids undergo very rapid microbial degradation in soil.

6. Acute and Dietary Risks for Sensitive Subpopulations, Particularly Infants and Children

FFDCA section 408 provides that EPA shall apply an additional tenfold margin of exposure (safety) for infants and children in the case of threshold effects to account for prenatal and postnatal toxicity and the completeness of the data base unless EPA determines that a different margin of exposure (safety) will be safe for infants and children. Margins of exposure are often referred to as uncertainty or safety factors. In this instance, based on all available information, the Agency concludes that ammonium nonanoate, is practically non-toxic to mammals including infants and children. Because there are no threshold effects of concern to infants, children, and adults when ammonium nonanoate is used as labeled, the provision requiring an additional margin of safety does not apply. Further, the provisions of consumption patterns, special susceptibility, and cumulative effects do not apply. As a result, EPA has not used a margin of exposure approach to assess the safety of ammonium nonanate.

7. Aggregate Exposure from Multiple Routes Including Dermal, Oral and Inhalation

Aggregate exposure to ammonium nonanoate, may occur via oral and dermal routes. Since the acute oral toxicity of soap salts is low (Toxicity Category IV), the risks anticipated from oral exposure are considered minimal. The acute dermal toxicity is also low (Toxicity Category IV). Longer dermal exposures can produce mild to moderate irritation, but soap salts are not skin sensitizers. As a result, the anticipated risks from dermal exposure are considered minimal. Because the inhalation route is not a likely exposure pathway, the anticipated risks from inhalation exposure are also considered minimal. Therefore, the risks from aggregate exposure via oral, dermal, and inhalation exposure are a compilation of three low-risk exposure scenarios and are negligible when appropriate protective equipment is used.

The Agency has considered the various routes of exposure and potential risks of the product and determined that the proposed use of the active ingredient does not pose significant risk to all populations, including infants and children.

8. Cumulative Effects

Section 408(b)(2)(D)(v) of the FFDCA requires the Agency to consider the cumulative effect of exposure to pelargonic acid, ammonium salt, and to other substances that have a common mechanism of toxicity. These considerations include the possible cumulative effects of such residues on infants and children. Except for ocular exposure, ammonium nonanoate is of low toxicity, and it is not anticipated that there would be cumulative effects from common mechanisms of toxicity. The risk to eyes can be prevented by use of required protective eyewear.

9. Effects on the Immune and Endocrine Systems

EPA is required under the FFDCA, as amended by FQPA, to develop a screening program to determine whether certain substances (including all pesticide active and other ingredients) Amay have an effect in humans that is similar to an effect produced by a naturally-occurring estrogen, or other such endocrine effects as the Administrator may designate. Following the recommendations of its Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC), EPA determined that there was scientific basis for including, as part of the program, the androgen and thyroid systems, in addition to the estrogen hormone system. EPA also adopted EDSTAC's recommendation that the program include evaluations of potential effects in wildlife. For pesticide chemicals, EPA will use FIFRA and, to the extent that effects in wildlife may help determine whether a substance may have an effect in humans, FFDCA authority to require the wildlife evaluations. As the science develops and resources allow, screening of additional hormone systems may be added to the Endocrine Disruptor Screening Program (EDSP).

The Agency is not requiring information on the endocrine effects of the active ingredient ammonium nonanoate, at this time. The Agency has considered, among other relevant factors, available information concerning whether the active ingredient may have an effect in humans similar to an effect produced by a naturally occurring estrogen or other endocrine effects. There is no known metabolite that acts as an "endocrine disrupter" produced by this active ingredient. Based on the low potential exposure level associated with the proposed use of this pesticide, the Agency expects no incremental adverse effects to the endocrine or immune systems.

C. ENVIRONMENTAL ASSESSMENT

1. Ecological Effects Hazard Assessment

The registrant requested a waiver of the data requirement for background non-target plant testing (Guideline 154-10, OPPTS 850.4000). This request was based on the fact that the mode of action for ammonium nonanoate is physical contact, i.e., the product works only when the leaves of a plant are completely drenched with the herbicide solution. Ammonium nonanoate has no systemic or residual activity. Therefore, non-target plants will not be affected by spray drift, since a plant must be thoroughly saturated to the "drip-stage" with the product for herbicidal activity to occur. Incidental exposure to plants via spray drift will have no permanent adverse effects on non-target plants. Spray drift can be mitigated by increasing spray droplet size. The Agency granted this request to waive data requirements for non-target plant testing.

No studies or waiver requests were submitted for the remainder of the Tier I non-target organism data requirements, although data contained in the Soap Salts RED (EPA, 1992) and the HERA Fatty Acid Salts (Soap) Environmental Risk Assessment (2003) may be used to support these data requirements. Based on information from the aforementioned reviews, soap salts of fatty acids are slightly toxic to birds on an acute basis and are practically non-toxic to birds on a dietary basis, slightly toxic to fish, and highly toxic to aquatic invertebrates. Ammonium salts of fatty acids are readily biodregradable and rapidly metabolized by soil microorganisms (half life < 1day). Since the product is not intended for direct application to aquatic sites, exposure to aquatic organisms (fish and invertebrates) is further mitigated. No data are available for non-target insects, the registrant must have restrictive label language in regard to non-target insects (honey bees).

Based on data contained in the Soap Salts RED (EPA, 1992) and HERA (2003), there are no concerns for non-target organisms when ammonium nonanoate is used in accordance with approved labeling.

Table3: Non-target Organism Data from the Soap Salts RED (EPA, 1992) and HERA (2003)

Data Requirement	**LD50\LC50\EC50**	**Toxicity Category**	**Citation**
Avian Acute Oral Toxicity OPPTS 850.2100	>2150 mg/kg (bobwhite quail)	Slightly toxic	MRID 41767112
Avian Dietary Toxicity OPPTS 850.2200	>5000 mg/kg (bobwhite quail & mallard duck)	Practically non-toxic	MRID 41767113, -14
Acute Fish Toxicity OPPTS 850.1075	96-hr: 18.06 mg/L (rainbow trout) 96 hr: 35.35 mg/L[1] (bluegill sunfish)	Slightly toxic	EPA. (1992)
	96 hr: 54 mg/L[2] (*O. latipes*)	Slightly toxic	HERA (2003)
Aquatic Invertebrates OPPTS 850.1010	48 hr: 0.57 mg/L (*D. magna*)	Highly toxic	MRID 400662-00
Non-Target Plants OPPTS 870.2500	No data available for any soap salt but product is intended for use as a terrestrial herbicide	-	-
Non-target Insects OPPTS 850.3020; 850.3030; 850.3040	No data available for any soap salt	-	-

[1] potassium soap salt used; considered by the Agency to be equivalent to ammonium soap salt for ecorisk assessment purposes (EPA, 1992).

2 sodium decanoate (C_{10} fatty acid salt) was test substance.

2. Environmental Fate and Ground Water Data

The need for environmental fate and groundwater data [Tier II, 40 CFR 158.690(d)] was not triggered because the Tier I studies were waived. Risk is minimal due to the low toxicity, use pattern, and rapid microbial degradation of the active ingredient.

3. Ecological Exposure and Risk Characterization

According to the RED (EPA-738-F-92-013, September, 1992), end use products containing ammonium salts of fatty acids are expected to degrade rapidly, primarily via microbial action, with a half-life of perhaps less than one day. The Agency therefore believes that ammonium salts of fatty acids, when used as directed, will not persist in the environment. Data reviewed suggest that ammonium salts of fatty acids are not very toxic to upland avian species or waterfowl by either acute or dietary exposure. The RED states that ammonium salts of fatty acids are probably only slightly toxic to both warm water and cold water fish species, but are considered highly toxic to aquatic invertebrates. However, the use of ammonium nonanoate following label directions should not result in serious impact to aquatic invertebrates because it is not applied directly to water and undergoes very rapid microbial degradation in soil. In addition, mitigating label language will further reduce the risk to aquatic invertebrates. The precautionary labeling for the end use product stipulates "This product may be hazardous to aquatic invertebrates. Do not apply to water bodies such as ponds or creeks, areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water by cleaning of equipment, or disposal of rinse water into such water bodies."

D. EFFICACY DATA

No efficacy data were required to be submitted to the Agency, since no public health uses are involved.

IV. RISK MANAGEMENT DECISION

A. DETERMINATION OF ELIGIBILITY

Section 3(c)(7)(C) of FIFRA provides for the unconditional registration of new active ingredients if it is determined that (A) its composition is such as to warrant the proposed claims for it; (B) its labeling and other materials required to be submitted comply with the requirements of FIFRA; (C) it will perform its intended function without unreasonable adverse effects on the environment; and (D) when used in accordance with widespread and commonly recognized practice, it will not generally cause unreasonable adverse effects on the environment.

To satisfy criteria "A" above, ammonium nonanoate, is not expected to cause unreasonable adverse effects when used according to label instructions. Criteria "B" is satisfied by the current label and by data presented in this document. It is believed that ammonium nonanoate will not cause any unreasonable adverse effect, and is an effective biochemical pesticide for unwanted vegetation, satisfying Criteria "C." Criteria "D" is satisfied in that the pesticide is not expected to cause unreasonable adverse effects when used as described on the label. Therefore, ammonium nonanoate is eligible for an unconditional registration.

B. REGULATORY POSITION

1. Unconditional Registration

The data submitted are sufficient for an unconditional registration of ammonium nonanoate an end use product.

2. Tolerance Reassessment

There is currently no tolerance or tolerance exemption for ammonium salts of fatty acids. A Proposed Rule was published on May 1, 1996 (61FR 19233-36) to exempt ammonium oleate and related C8-C18 fatty acids ammonium salts from the requirement of a tolerance for residues in or on all raw agricultural commodities when used in accordance with good agricultural practice; however, the proposed rule was never finalized by the Agency.

3. Codex Harmonization

There are no Codex harmonization considerations since there is currently no Codex tolerance for residues of ammonium nonanoate.

4. Nonfood Re/Registrations

This is a new active ingredient and, therefore, not the subject of reregistration at this time.

5. Risk Mitigation

A risk exists from ocular exposure, which is mitigated by label language requiring protective eyewear. Risk to aquatic invertebrates is mitigated by the appropriate label precautions.

6. Endangered Species Statement

Based on the non-target organism data submitted and reviewed in the Soap Salts RED (EPA, 1992) and in the HERA Fatty Acid Salts (Soap) Environmental Risk Assessment (2003), and the ready biodegradability of the active ingredient, there will be **No Adverse Affects (NAE)** to threatened and endangered species when the product is used in accordance with approved labeling.

C. LABELING RATIONALE

It is the Agency's position that the labeling for the end use product containing 40.0% by weight of the active ingredient ammounium nonanoate complies with the current pesticide labeling requirements.

1. Human Health Hazard

a. **Worker Protection Standard**: Any product whose labeling reasonably permits its use in the production of an agricultural plant on any farm, forest, nursery, or greenhouse must comply with the labeling requirements of PR Notice 93-7, "Labeling Revisions required by the Worker Protection Standard (WPS), and PR Notice 93-11, "Supplemental Guidance for PR Notice 93-7", which reflect the requirements of EPA's labeling regulations for worker protection statements (40 CFR part 156, subpart K). These labeling revisions are necessary to implement the Worker Protection Standard for Agricultural Pesticides (40 CFR part 170). Unless otherwise specifically directed, all statements required by PR Notices 93-7 and 93-11 are to be on the product label exactly as instructed in those Notices.

The labels and labeling of all products must comply with EPA's current regulations and requirements as specified in 40 CFR 156.10 and other applicable notices, such as, and including, the WPS labeling.

b. **Non-Worker Protection Standard**: There are no non-WPS human health hazard issues.

c. **Precautionary Labeling:** The Agency has examined the toxicological data base for ammonium nonanoate, ammonium salt and concluded that the precautionary labeling required during this unconditional registration process (i.e. Signal Word, First Aid Statements, and other label statements) adequately mitigates the risks associated with the proposed uses.

d. **End Use Product Precautionary Labeling:** For Racer™ Concentrate, "WARNING." "Inhalation may cause nose, throat, and lung irritation on prolonged exposure to spray and should be minimized. Skin contact should be avoided by the use of long sleeved shirts and chemical resistant gloves and boots. Fatty acid salts are known eye irritants, so goggles, safety glasses with side shields or full faceshields must be used during mixing operations and application." **The ammonium soaps of higher fatty acids discussed in the RED are labeled "DANGER" due to potential for permanent eye damage.**

e. **Spray Drift Advisory** No spray drift advisory statement is necessary for this use.

2. Environmental Hazards Labeling

End-Use Product Environmental Hazards Labeling: "This product may be hazardous to aquatic invertebrates. Do not apply to water bodies such as ponds or creeks, areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water by cleaning of equipment, or disposal of rinse water into such water bodies."

3. Application Rate

It is the Agency's position that the labeling for the end use product, which contains 40% by weight ammonium nonanoate, complies with the current pesticide labeling requirements. The product label directs the user to apply up to a maximum concentration of 6% by weight, corresponding to 2.4% by weight ammonium nonanoate, in water.

D. LABELING

Product Name: **Racer™ Concentrate**

ACTIVE INGREDIENT	
Ammonium nonanoate	40.0%
Other ingredients	60.0%
Total	100.0%

The end use product label shall comply with Agency labeling requirements and must contain the following information:

- Product name
- Ingredient statement
- Registration number
- "Keep out of reach of children"
- Signal word (CAUTION)
- Precautionary statements

V. ACTIONS REQUIRED BY REGISTRANTS

Registrants are required to provide reports of incidents of adverse effects to humans or domestic animals under FIFRA, Section 6(a)(2) and incidents of hypersensitivity under 40 CFR Part 158.690(c), guideline reference number 152-16. There are no data requirements, label changes and other responses necessary for the reregistration of the product since the product is being registered after November 1984 and is, therefore, not subject to reregistration. For the same reason, there are also no existing stocks provisions at this time.

VI. APPENDIX A

Table 4 lists the use sites for the product. The label for the product is also attached.

TABLE 4: Use Sites. Registration/Reregistration	
Racer™ Concentrate Use sites: Field, greenhouse, turf, and nursery use.	**Official date registered:**

APPENDIX B – REFERENCES

Forster, V., and R.A. Smiley. 2005. Ammonium Nonanoate, A.P.: 40% SC (End-Use Product). Product Properties, Group A-Product Identity, Compsition, and Analysis. Falcon Lab, LLC Study ID Number Series 880.1100-880.1400 and Series 830.1700-830.1800. MRID 46640401.

Forster, V., and R.A. Smiley. 2005. Ammonium Nonanoate, A.P.: 40% SC (End-Use Product). Product Properties, Group B-Physical/Chemical Properties. Falcon Lab, LLC Study ID Number AP-PC-01, Series 830.6302-830.7100. MRID 46640402.

Ammonium Nonanoate, A.P.: 40% SC (End-Use Product). Waiver Request. Nontarget Plant Background. MRID 46640404.

Ammonium Nonanoate, A.P.: 40% SC (End-Use Product). Waiver Request. Toxicology Data Requirements. MRID 46640403.

Ammonium Nonanoate, A.P.: 40% SC (End-Use Product). Administrative Documents – Data Summaries. Attachment A: Introduction and Pages 1-21 of the Registration Eligibility Document (RED) for Soap Salts, EPA, 1992.

Ammonium Nonanoate, A.P.: 40% SC (End-Use Product). Administrative Documents – Data Summaries. Attachment B: Fact Sheet for Soap Salts RED, EPA.

Ammonium Nonanoate, A.P.: 40% SC (End-Use Product). Administrative Documents – Data Summaries. Attachment C: 61FR19233:Proposed Rule to Exempt Ammonium Soap Salts from the Requirement of a Tolerance, May 1, 1996.

Ammonium Nonanoate, A.P.: 40% SC (End-Use Product). Administrative Documents – Data Summaries. Attachment D: 69FR12670: Notice of Filing to Exempt Ammonium Nonanoate from the Requirement of a Tolerance, March 17, 2004.

Ammonium Nonanoate, A.P.: 40% SC (End-Use Product). Administrative Documents – Data Summaries. Attachment E: Fatty Acid Salts. Human Health Risk Assessment. Draft (2002), and Fatty Acid Salts (Soap). Environmental Risk Assessment. Draft (2003). Published by the European Organization HERA (Human and Environmental Risk Assessment).

Exhibit M

http://www.epa.gov/EPA-PEST/2008/July/Day-09/p15516.htm
Last updated on Monday, December 29th, 2008.

Federal Register Environmental Documents

You are here: EPA Home Federal Register FR Years FR Months FR Days FR Documents
Ammonium Soap Salts of Higher Fatty Acids (C_8-C_{18} saturated; C_8-C_{12}) unsaturated; Exemption from the Requirement of a Tolerance

01-06-10A08:06 CFMD

Ammonium Soap Salts of Higher Fatty Acids (C_8-C_{18} saturated; C_8-C_{12}) unsaturated; Exemption from the Requirement of a Tolerance

PDF Version (6 pp, 130K, About PDF)

[Federal Register: July 9, 2008 (Volume 73, Number 132)]
[Rules and Regulations]
[Page 39264-39269]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
[DOCID:fr09jy08-19]

ENVIRONMENTAL PROTECTION AGENCY
40 CFR Part 180
[EPA-HQ-OPP-2007-0571; FRL-8372-2]

Ammonium Soap Salts of Higher Fatty Acids
(C_8-C_{18} saturated; C_8-C_{12})
unsaturated; Exemption from the Requirement of a Tolerance

AGENCY: Environmental Protection Agency (EPA).
ACTION: Final rule.

SUMMARY: This regulation establishes an exemption from the requirement of a tolerance for residues of the ammonium soap salts of higher fatty acids (C_8-C_{18} saturated; C_8-C_{12} unsaturated) in or on all food commodities when applied for the suppression and control of a wide variety of grasses and weeds. Falcon Lab, LLC submitted a petition to EPA under the Federal Food, Drug, and Cosmetic Act (FFDCA), as amended by the Food Quality Protection Act of 1996 (FQPA), requesting an exemption from the requirement of a tolerance. This regulation eliminates the need to establish a maximum permissible level for residues of ammonium soap salts of higher fatty acids (C_8-C_{18} saturated; C_8-C_{12} unsaturated).

TES: This regulation is effective July 9, 2008. Objections and requests for hearings must be received on or before September 8, 2008, and must be filed in accordance with the instructions provided in 40 CFR part 178 (see also Unit I.C. of the SUPPLEMENTARY INFORMATION).

ADDRESSES: EPA has established a docket for this action under docket identification (ID) number EPA-HQ-OPP-2007-0571. To access the lectronic docket, go to http://www.regulations.gov, select ``Advanced earch,'' then ``Docket Search.'' Insert the docket ID number where indicated and select the ``Submit'' button. Follow

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the instructions on the regulations.gov website to view the docket index or access available documents. All documents in the docket are listed in the docket index available in regulations.gov. Although listed in the index, some information is not publicly available, e.g., Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, is not placed on the Internet and will be publicly available only in hard copy form. Publicly available docket materials are available in the electronic docket at http://www.regulations.gov, or, if only available in hard copy, at the OPP Regulatory Public Docket in Rm. S-4400, One Potomac Yard (South Bldg.), 2777 S. Crystal Dr., Arlington, VA. The Docket Facility is open from 8:30 a.m. to 4 p.m., Monday through Friday, excluding legal holidays. The Docket Facility telephone number is (703) 305-5805.

FOR FURTHER INFORMATION CONTACT: Raderrio Wilkins, Biopesticides and Pollution Prevention Division (7511P), Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20460-0001; telephone umber: (703) 308-1259; e-mail address: wilkins.raderrio@epa.gov.

SUPPLEMENTARY INFORMATION:

I. General Information

A. Does this Action Apply to Me?

You may be potentially affected by this action if you are an agricultural producer, food manufacturer, or pesticide manufacturer. Potentially affected entities may include, but are not limited to those engaged in the following activities:

- Crop production (NAICS code 111).
- Animal production (NAICS code 112).
- Food manufacturing (NAICS code 311).
- Pesticide manufacturing (NAICS code 32532).

This listing is not intended to be exhaustive, but rather to provide a guide for readers regarding entities likely to be affected by this action. Other types of entities not listed in this unit could also be affected. The North American Industrial Classification System (NAICS) codes have been provided to assist you and others in determining whether this action might apply to certain entities. If you have any questions regarding the applicability of this action to a articular entity, consult the person listed under FOR FURTHER FORMATION CONTACT.

B. How Can I Access Electronic Copies of this Document?

In addition to accessing an electronic copy of this Federal Register document through the electronic docket at http://www.regulations.gov, you may access this Federal Register document electronically through the EPA Internet under the ``Federal Register'' listings at http://www.epa.gov/fedrgstr. You may also access a frequently updated electronic version of EPA's tolerance regulations at 40 CFR part 180 through the Government Printing Office's pilot e-CFR site at http://www.gpoaccess.gov/ecfr.

C. Can I File an Objection or Hearing Request?

Under section 408(g) of FFDCA, any person may file an objection to any aspect of this regulation and may also request a hearing on those objections. You must file your objection or request a hearing on this regulation in accordance with the instructions provided in 40 CFR part 178. To ensure proper receipt by EPA, you must identify docket ID number EPA-HQ-OPP-2007-0571 in the subject line on the first page of your submission. All requests must be in writing, and must be mailed or delivered to the Hearing Clerk as required by 40 CFR part 178 on or before September 8, 2008.

In addition to filing an objection or hearing request with the Hearing Clerk as described in 40 CFR part 178, please submit a copy of the filing that does not contain any CBI for inclusion in the public docket that is described in ADDRESSES. Information not marked confidential pursuant to 40 CFR part 2 may be disclosed publicly by EPA without prior notice. Submit this copy, identified by docket ID number EPA-HQ-OPP-2007-0571, by one of the following methods:

- Federal eRulemaking Portal: http://www.regulations.gov. Follow the on-line instructions for submitting comments.
- Mail: Office of Pesticide Programs (OPP) Regulatory Public Docket (7502P), Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20460-0001.
- Delivery: OPP Regulatory Public Docket (7502P), Environmental Protection Agency, Rm. S-4400, One Potomac Yard (South Bldg.), 2777 S. Crystal Dr., Arlington, VA. Deliveries are only accepted during the Docket's normal hours of operation (8:30 a.m. to 4 p.m., Monday through Friday, excluding legal holidays). Special arrangements should be made for deliveries of boxed information. The Docket Facility telephone number is (703) 305-5805.

II. Background and Statutory Findings

In the Federal Register of August 8, 2007 (72 FR 44521) (FRL-8139-7), EPA issued a notice pursuant to section 408(d)(3) of FFDCA, 21 U.S.C. 346a(d)(3), announcing the filing of a pesticide tolerance petition (PP 7F7186) by Falcon Lab, LLC, 1103 Norbee Drive, Wilmington, DE 19803. The petition requested that 40 CFR part 180 be amended by establishing an exemption from the requirement of a tolerance for residues of ammonium soap salts of higher fatty acids (C_8-C_{18} saturated and $_{}$-C_{12} unsaturated). This notice failed to include a summary of the petition prepared by the petitioner Falcon Lab, LLC, nor was a summary of the petition provided in the docket for this action. Therefore, EPA republished notice of receipt of this petition in the Federal Register of April 16, 2008 (73 FR 20631) (FRL-

8360-1), and posted the summary of the petition in the docket for this action. There were no comments received in response to the notice of filing.

Section 408(c)(2)(A)(i) of FFDCA allows EPA to establish an emption from the requirement for a tolerance (the legal limit for a pesticide chemical residue in or on a food) only if EPA determines that the exemption is ``safe.'' Section 408(c)(2)(A)(ii) of FFDCA defines ``safe'' to mean that ``there is a reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue, including all anticipated dietary exposures and all other exposures for which there is reliable information.'' This includes exposure through drinking water and in residential settings, but does not include occupational exposure. Pursuant to section 408(c)(2)(B) of FFDCA, in establishing or maintaining in effect an exemption from the requirement of a tolerance, EPA must take into account the factors set forth in section 408(b)(2)(C) of FFDCA, which require EPA to give special consideration to exposure of infants and children to the pesticide chemical residue in establishing a tolerance and to ``ensure that there is a reasonable certainty that no harm will result to infants and children from aggregate exposure to the pesticide chemical residue.... '' Additionally, section 408(b)(2)(D) of FFDCA requires that the Agency consider ``available information concerning the cumulative effects of a particular pesticide's residues '' and ``other substances that have a common mechanism of toxicity.''

EPA performs a number of analyses to determine the risks from aggregate exposure to pesticide residues. First,

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EPA determines the toxicity of pesticides. Second, EPA examines exposure to the pesticide through food, drinking water, and through other exposures that occur as a result of pesticide use in residential settings.

III. Toxicological Profile

Consistent with section 408(b)(2)(D) of FFDCA, EPA has reviewed the available scientific data and other relevant information in support of this action and considered its validity, completeness, and reliability and the relationship of this information to human risk. EPA has also considered available information concerning the variability of the sensitivities of major identifiable subgroups of consumers, including infants and children.

Ammonium soap salts of fatty acids are one class of salts of fatty acids. Soaps are mineral salts of naturally occurring fatty acids. The fatty acids are a significant part of the normal daily diet, for they occur in dietary lipids which usually constitute about 90 grams in a day's diet. As discussed in this Unit, as part of the reregistration process, the Agency has already conducted a risk assessment for soap salts of fatty acids for their potential effects to human health and the environment and determined that all registered pesticide products ntaining the active ingredient Soap Salts are not likely to cause unreasonable adverse effects in people or the environment and were eligible for reregistration.

The Agency issued a Reregistration Eligibility Document (RED) in

September 1992 for potassium salts of fatty acids (C_{12}-C_{18} saturated and C_{18} unsaturated, including potassium laureate, potassium myristate, otassium oleate, and potassium ricinoleate (CAS No. 10124-65-9) and mmonium salts of fatty acids (C_8-C_{18} saturated and C_{18} unsaturated, including ammonium oleate (CAS No. 84776-33-0). While the RED does not specifically identify the active ingredient ammonium nonanoate (also called pelargonic acid) by name, the Agency believes the conclusions of the RED are applicable to ammonium nonanoate because the RED defines the soap salts of fatty acids that were assessed to be (C_8-C_{18}) and ammonium nonanoate (pelargonic acid) is an ammonium salt of C_9 fatty acid. All soap salts with fatty acids having aliphatic carbon chains lengths in the range between C_8 and C_{18} saturated and C_8-C_{12} unsaturated are virtually identical in regard to chemistry and toxicology.

In support of the RED, the Agency conducted a risk assessment for soap salts for their potential effects (if any) to human health. The Agency determined that soap salts of fatty acids are metabolized, forming simple compounds that serve as energy sources and structural compounds used in all living cells, and have low acute toxicity by the oral route of exposure. The RED notes that soap salts of potassium salts of coco fatty acid and sodium salts of caprylic acid, when administered to lab animals at high doses cause reproductive and mutagenic effects. However, based on the low toxicity of ammonium nonanoate and data/information reviewed in support of the tolerance emption for pelargonic acid (ammonium nonanoate acid) which demonstrated that pelargonic acid did not cause developmental or mutagenic effects, the Agency believes that there would likely not be any reproductive or mutagenic effects for this active ingredient when used in the manner as described in this rule. Further the pesticidal concentration of ammonium nonanoate will be exceedingly lower in comparison to those high doses which were administered in the studies using potassium salts of coco fatty acids.

The active ingredient ammonium soap salts of fatty acids, is used as a contact, non-selective, broad spectrum, foliar-applied herbicides. This active ingredient was federally registered in 2006 as a non-food use pesticide for the suppression and control of a wide variety of undesirable grasses and weeds. In addition, ammonium salts of fatty acids have been registered for other non-food uses, including repelling rabbits and deer from forage and grain crops, vegetables and field crops, in orchards, and on nursery stock, ornamentals, flower, lawns, turfs, vines, shrubs and trees.

As part of this rulemaking, EPA reviewed the Soap Salts of Fatty Acid RED, the Pelargonic Acid Tolerance Exemption (40 CFR 180.1159), the data and/or information submitted by the petitioner and has concluded that ammonium nonanoate, a C_9 ammonium salt fatty acid (also called pelargonic acid) and other ammonium soap salts of higher fatty acids (C_8-C_{18} saturated; C_{12} unsaturated) do not pose an unreasonable adverse effect to the environment, when used in accordance with approved labeling. While this pesticide is not intended to be sprayed directly on food or feed crops, the Agency has determined that there may be a potential for exposure from residues of ammonium soap salts on food and feed as a result of unintentional spray or drift.

In lieu of submitting new Tier I toxicity studies for ammonium nonanoate, the registrant relied on data previously submitted in support of the Soap Salts Registration Eligibility Document (RED). The RED concluded that fatty acids such as oleic acids and related C_{12}-C_{18} fatty acids are generally considered to be low toxicity by the oral route of exposure and gives a category IV for both oral and dermal route of exposure. This conclusion can be extended to all ammonium salts of fatty acids (C_8-C_{18} saturated; C_8-C_{12} unsaturated) because of the virtual identical chemistry and toxicology of these fatty acids.

In addition to relying on the RED, the petitioner submitted requests for waiver of additional studies in support of its petition for a tolerance exemption.

1. Acute inhalation toxicity: Ammonium salts of fatty acids do not form aerosol particulates, have a vapor pressure near that of water and do not readily vaporize. ``In a study in which 10 rats were exposed for 8 hours to saturated vapors of mixed isomers of decanoic acid (C_{10}) no deaths were observed.'' MRID 43843503 reported that the LC_{50} was > 1.244 milligrams/liter (mg/L) for nonanoic acid (C_9).

2. Subchronic oral toxicity: MRID 43843507 reported that no significant effects were demonstrated in a 14-day range finding study in rats given nonanoic acid at doses up to 1,834 mg/kilogram (kg)/day. ``The agency concluded that a 90-day oral toxicity study was not necessary for a dietary risk assessment'' of nonanoic acid due to the following:

i. Lack of effects at extremely high doses in the range finding study;

ii. Nature of nonanoic acid (a fatty acid) and its ubiquity in nature;

iii. The results from acute mammalian toxicology studies; and

iv. The unlikelihood of prolonged human exposure via the oral route due to the proposed use patterns.

Dietary exposure would be minimized via plant metabolism of ammonium nonanoic acid through oxidative pathways common for fatty acids. The same rationale can be applied to ammonium salts of fatty acids because they share a chemical identity with ammonium nonanoic acid.

3. Teratogenicity: MRID 43843508, a developmental toxicity study of nonanoic acid (C_9 fatty acid), reported that the treatment had no adverse effects on clinical signs, body weight, or food/water consumption. No fetal toxicity was observed. The mean number of viable fetuses, early or late resorptions, implantation sites, corpora lutea, pre- and post-implantation losses, sex ratios and fetal body weight were comparable to those of the control group. The no observed adverse effect level (NOAEL)

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for maternal and developmental toxicity was 1,500 mg/kg/day and the lowest observed adverse effect level (LOAEL) was > 1,500 mg/kg/day. The developmental toxicity study for ammonium nonanoic acid showed no effects at dose levels above the limit dose (1,000 mg/kg/day). Therefore, the tier 1 data requirement for food use for this biochemical pesticide is satisfied. The same rationale can be applied to ammonium salts of fatty acids because they share a chemical identity with ammonium nonanoic acid.

4. Immune response: This study is conditionally required when there is a requirement for a sub-chronic oral, dermal, or inhalation study, depending on the most likely routes of exposure. The registrant requested waivers based on the factors given for the waiver request of the 90-day oral toxicity study.

IV. Aggregate Exposures

In examining aggregate exposure, section 408 of FFDCA directs EPA to consider available information concerning exposures from the pesticide residue in food and all other non-occupational exposures, including drinking water from ground water or surface water and exposure through pesticide use in gardens, lawns, or buildings (residential and other indoor uses).

Aggregate exposure to ammonium salts may occur via oral and dermal routes. Since the acute oral toxicity of soap salts is low (Toxicity Category IV), the risks anticipated from oral exposures are considered minimal. The acute dermal toxicity is also low (Toxicity Category IV). Longer dermal exposures can produce mild to moderate irritation, but soap salts are not skin sensitizers. As a result, the anticipated risks from dermal exposure are considered minimal. Since the inhalation route is not a likely exposure pathway the anticipated risk from inhalation exposure are also considered minimal.

Dietary Exposure

1. Food. Pesticides containing ammonium soap salts of fatty acids are likely to be used as contact, non-selective, broad spectrum, foliar-applied herbicides or as repellents. As such they are likely not to be applied directly to any food plants. Moreover, ammonium salts of fatty acids are expected to be rapidly metabolized by soil microorganisms, with a half-life of perhaps less than one day, therefore residues of ammonium salts of fatty acids when used in accordance with approved labeling will not persist in the environment. The lack of direct application to food plants coupled with the rapid metabolization of ammonium salts when used as pesticides will result in low exposures to ammonium soap salts of fatty acids. However, if the exposures to ammonium soap salts to humans from food commodities that have been indirectly sprayed with residues of ammonium salts occur, the Agency does not expect exposures to be unsafe due the low acute toxicity and likely low exposure of these soap salts.

2. Drinking water exposure. No significant exposure to drinking water is expected from an accumulation of soap salts in the aquatic environment when it is used in accordance with approved labeling. Ammonium salts of fatty acids are not to be applied directly to water.

B. Other Non-Occupational Exposure

Non-occupational dermal exposure to ammonium salts of fatty acids will be expected since the use of this pesticide will be in the residential settings. However, the Agency believes that any hazard related to exposure to residential users from this pesticide will likely be insignificant. This belief is based on the fact that the toxicity data demonstrated no toxic endpoints upon which to base a risk characterization at or below 1,000 mg/kg of body weight/day (the limit dose).

Non-occupational inhalation exposure is not expected because ammonium salts of fatty acids do not form aerosol particulates, have a vapor pressure near that of water, and do not readily vaporize.

V. Cumulative Effects

Section 408(b)(2)(D)(v) of the FFDCA requires the Agency to consider the cumulative effect of exposure to residues that have a common mechanism of toxicity. These considerations include the possible cumulative effects of such residues on infants and children. Except for ocular exposure, ammonium nonanoate is of low toxicity, and it is not anticipated that there would be cumulative effects from common mechanisms of toxicity.

Studies of fatty acids and fatty acid salts previously submitted to the Agency, indicate that the half-life of fatty acids is less than one (1) day (MRID 00157476). As can be expected, there is very rapid microbial degradation of fatty acids in soil. Fatty acids and their salts are excellent substrates for microbial growth, serving both as carbon sources and energy sources. The active ingredient cannot totally dissipate from soil, because there is a natural content of fatty acids in soil resulting from plant metabolism and by formation of microbial organisms. Fatty acids constitute a significant portion of the normal daily diet of mammals (including humans, birds, and invertebrates since they are found in large amounts in the form of lipids in all living tissues (including seeds). Microbial metabolism of fatty acids has the effect of either converting the degradates to CO2 and ester (if used as an energy source) or converting the carbon content of the fatty acid to any of the thousands of naturally occurring organic substances produced by the soil microflora (if used as a carbon source). Based on these known facts of the role of fatty acids in the environment and in food and feed, there should be no concern for cumulative effects of ammonium salts of fatty acids used as pesticides.

VI. Determination of Safety for U.S. Population, Infants and Children

There is a reasonable certainty that no harm to the U.S. population, including infants and children , will result from aggregate exposure to residues of ammonium salts of fatty acids (C_8-C_{18} saturated; C_8-C_{12} unsaturated) due to their use as a pesticide. This includes all anticipated dietary exposures and all other exposures for which there is reliable information. As discussed in Unit III, ammonium salts of fatty acids (C_8-C_{18} saturated; C_8-C_{12} unsaturated) have low toxicity. Moreover, many soap salts of fatty acids are part of the human diet and pesticide exposures are not expected to exceed the levels of naturally occurring fatty acids in commonly eaten foods. Accordingly, exempting ammonium salts of fatty acids (C_8-C_{18} saturated; C_8-C_{12} unsaturated) from the requirement of a tolerance is considered safe.

FFDCA section 408 provides that EPA shall apply an additional tenfold margin of exposure MOE (safety) for infants and children in the case of threshold effects to account for prenatal and postnatal toxicity and the completeness of the data base unless EPA determines that a different margin of exposure (safety) will be safe for infants and children. Margins of exposure are often referred to as uncertainty or safety factors. In this instance, based on all available information, the Agency concludes that ammonium salts of fatty acids are practically non-toxic to mammals including infants and children. Because there are no threshold effects of concern to infants, children, and adults when ammonium salt is used as labeled, the provision requiring an additional margin of safety does not apply. Further, the provisions of consumption patterns, special susceptibility, and cumulative

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effects do not apply. As a result, EPA has not used a MOE approach to assess the safety of ammonium salts of fatty acids (C_8-C_{18} saturated; C_8-C_{12} unsaturated).

VII. Other Considerations

A. Endocrine Disruptors

EPA is required under the FFDCA, as amended by FQPA, to develop a screening program to determine whether certain substances (including all pesticide active and other ingredients) ``may have an effect in humans that is similar to an effect produced by a naturally-occurring estrogen, or other such endocrine effects as the Administrator may designate''. Ammonium salts of fatty acids (C_8-C_{18} saturated; C_8-C_{12} unsaturated) are not known endocrine disruptors nor are they related to any class of known endocrine disruptors.

B. Analytical Method(s)

There have been no analytical procedures conducted to ascertain residuals of ammonium salts of fatty acids (C_8-C_{18} saturated; C_8-C_{12} unsaturated) on food crops that have been exposed to pesticides containing such ammonium salts of fatty acids. Naturally occurring fatty acids constitute a significant part of the normal daily diet and are of low toxicity when taken orally and pose no known health risks. Further, based on data and/or information already reviewed by the Agency in support of the reregistration of soap salts of fatty acids, the residues of these salts of fatty acids from pesticide use are not likely to exceed and are likely to be indistinguishable from levels of naturally occurring fatty acids in commonly eaten foods.

C. Codex Maximum Residue Level

There are currently no established Codex, Canadian, or Mexican MRLs for ammonium salts of fatty acids in/on plants or livestock commodities. Therefore, no compatibility issues exist with regard to the proposed U.S. exemption from the requirement of a tolerance.

VIII. Conclusions

There is currently no tolerance or tolerance exemption for ammonium salts of fatty acids. A proposed rule was published on May 1, 1996 (61 FR 19233) (FRL-5362-9), to exempt ammonium oleate and related C_8-C_{18} fatty acids ammonium salts from the requirement of a tolerance for residues in or on all raw agricultural commodities when used in accordance with good agricultural practice; however, the proposed rule was never finalized by the Agency. This action will formalize food use approval for ammonium salts of fatty acids as stated in the 1992 RED: Soap Salts, by exempting ammonium salts of higher fatty acids from the requirement of a tolerance.

The Agency has determined that there is a reasonable certainty that no harm will result to the U.S. population, including infants and children from aggregate exposures to residues of ammonium salts of fatty acids (C_8-C_{18} saturated; C_8-C_{12} unsaturated). This conclusion is based on the demonstrated, very low acute oral and dermal toxicity of these ammonium salts and because the Agency anticipates that actual exposures in food will be low due to the uses of ammonium soap salts of fatty acids.

IX. Statutory and Executive Order Reviews

This final rule establishes a tolerance under section 408(d) of FFDCA in response to a petition submitted to the Agency. The Office of anagement and Budget (OMB) has exempted these types of actions from review under Executive Order 12866, entitled Regulatory Planning and Review (58 FR 51735, October 4, 1993). Because this final rule has been exempted from review under Executive Order 12866, this final rule is not subject to Executive Order 13211, Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use (66 FR 28355, May 22, 2001) or Executive Order 13045, entitled Protection of Children from Environmental Health Risks and Safety Risks (62 FR 19885, April 23, 1997). This final rule does not contain any information collections subject to OMB approval under the Paperwork Reduction Act (PRA), 44 U.S.C. 3501 et seq., nor does it require any special considerations under Executive Order 12898, entitled Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (59 FR 7629, February 16, 1994).

Since tolerances and exemptions that are established on the basis of a petition under section 408(d) of FFDCA, such as the tolerance in this final rule, do not require the issuance of a proposed rule, the requirements of the Regulatory Flexibility Act (RFA) (5 U.S.C. 601 et seq.) do not apply.

This final rule directly regulates growers, food processors, food handlers, and food retailers, not States or tribes, nor does this action alter the relationships or distribution of power and responsibilities established by Congress in the preemption provisions section 408(n)(4) of FFDCA. As such, the Agency has determined that this action will not have a substantial direct effect on States or tribal governments, on the relationship between the national government and the States or tribal governments, or on the distribution of power and responsibilities among the various levels of government or between the Federal Government and Indian tribes. Thus, the Agency has determined that Executive Order 13132, entitled Federalism (64 FR 43255, ugust 10, 1999) and Executive Order 13175, entitled Consultation d Coordination with Indian Tribal Governments (59 FR 22951, November 9, 2000) do not apply to this final rule. In addition, this final rule does not impose any enforceable duty or contain any unfunded mandate as described under Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) (Public Law 104-4).

This action does not involve any technical standards that would require Agency consideration of voluntary consensus standards pursuant to section 12(d) of the National Technology Transfer and Advancement Act of 1995 (NTTAA), Public Law 104-113, section 12(d) (15 U.S.C. 272 note).

X. Congressional Review Act

The Congressional Review Act, 5 U.S.C. 801 et seq., generally provides that before a rule may take effect, the agency promulgating the rule must submit a rule report to each House of the Congress and to the Comptroller General of the United States. EPA will submit a report containing this rule and other required information to the U.S. Senate, the U.S. House of Representatives, and the Comptroller General of the United States prior to publication of this final rule in the Federal Register. This final rule is not a ``major rule'' as defined by 5 U.S.C. 804(2).

List of Subjects in 40 CFR Part 180

Environmental protection, Administrative practice and procedure, Agricultural commodities, Pesticides and pests, Reporting and recordkeeping requirements.

Dated: June 30, 2008.
Debra Edwards,
Director, Office of Pesticide Programs.

- Therefore, 40 CFR chapter I is amended as follows:

PART 180--[AMENDED]

- 1. The authority citation for part 180 continues to read as follows:

Authority: 21 U.S.C. 321(q), 346a and 371.

- 2. Section 180.1284 is added to subpart D to read as follows:

[[Page 39269]]

Sec. 180.1284 Ammonium salts of higher fatty acids (C_8-C_{18} saturated; C_8-C_{12} saturated); exemption from the requirement of a tolerance.

This regulation establishes an exemption from the requirement of a tolerance for residues of the ammonium salts of higher fatty acids C_8-C_{18} saturated; C_8-C_{12}

unsaturated on in or on all food commodities when applied for the suppression and control of a wide variety of grasses and weeds.

FR Doc. E8-15516 Filed 7-8-08; 8:45 am]
LLING CODE 6560-50-S

Notices For 2009 2008 2007 2006 2005 2004 2003 2002 2001 2000
1999 1998 1997 1996 1995 1994

EXHIBIT N

Falcon Lab LLC

RACER®

Concentrate
Non-selective Herbicide

FOR CONTACT SPRAY CONTROL OR BURNDOWN OF WEEDS AND GRASSES FOR FOOD CROPS, FIELD CROPS, PASTURES, ORNAMENTALS, TURF, LANDSCAPES, INTERIORSCAPES, GREENHOUSES, HOMES AND GARDENS, NON-CROP AREAS ON FARMSTEDS AND AROUND BUILDINGS AND INDUSTRIAL SITES

Active ingredient:	
Ammonium Nonanoate	40.0 wt.%
Other ingredients:	
Water	60.0 wt.%
Total	100.00 wt.%

RACER™ Concentrate contains 3.3 lbs. of ammonium nonanoate per U.S. gallon

This product is protected by U. S. Patent No. 6,323,156

EPA Reg. No.79766-1

EPA Establishment No.79766-

Net Contents:

KEEP OUT OF REACH OF CHILDREN

WARNING "AVISO"

"Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)"

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

WARNING

Causes substantial, but temporary eye injury. Causes skin irritation. Harmful if inhaled. Do not get in eyes, skin, or on clothing. Wash thoroughly with soap and water after handling. Remove and wash contaminated clothing before reuse.

FIRST AID	
If in eyes	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
If on skin or clothing	• Take off contaminated clothing • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
If inhaled	• Move person to fresh air • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. • Call a poison control center or doctor for treatment advice.
If swallowed	• Call poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to do so by the poison control center or doctor. • Do not give anything by mouth to an unconscious person.

HOT LINE NUMBER
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-424-9300 for emergency medical advice.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Applicators and other handlers must wear:

- Coveralls worn over short-sleeve shirt and short pants
- Socks and chemical resistant footwear
- Chemical resistant gloves
- Protective eyewear
- When mixing and loading wear a chemical resistant apron

Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. Do not reuse them. Follow the manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergents and hot water. Keep and wash PPE separately from other laundry.

USER SAFETY RECOMMENDATIONS

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS

For terrestrial uses: This pesticide is toxic to fish and aquatic invertebrates. Use care when applying in areas adjacent to any body of water. Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwater or rinsate. Drift and runoff may be hazardous to aquatic organisms in water adjacent to treated areas.
This product is toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product if bees are visiting the treatment area.

Notice: Read the entire label. Use only according to label directions. **Before using this product, read Warranty disclaimer, Inherent Risks of Use and Limitations of Remedies elsewhere on this label. If terms are unacceptable, return immediately unopened.**

For non-medical emergencies or spills, see **RACER® Concentrate** MSDS or call CHEMTREC at 800-424-9300.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the State/Tribal agency responsible for pesticide regulation.

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted-entry interval (REI) of 4 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated such as plants, soil, or water is:

- Coveralls worn over short-sleeve shirt and short pants
- Socks and chemical resistant footwear
- Chemical resistant gloves
- Protective eyewear

NON-AGRICULTURAL USE REQUIREMENTS

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.

Keep unprotected persons out of treated areas until sprays have dried.

STORAGE AND DISPOSAL

DO NOT contaminate water, food or feed by storage or disposal.

Pesticide Storage: Store container in cool place until used.

Pesticide Disposal: Wastes resulting from use of this product must be disposed of on-site or at an approved waste disposal facility.

Container Disposal: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

Homeowner Container Disposal:

If empty: Do not reuse this container. Place in trash or offer for recycling if available.

If partly filled: Call your local solid waste agency or 1-800-CLEANUP for disposal instructions. Never place unused product down any indoor or outdoor drain.

METHODS OF USE AND GENERAL APPLICATION INSTRUCTIONS

General Instructions:

RACER™ Concentrate is a contact non-selective herbicide for spray application only to undesirable plant growth. Do not allow spray to contact any green plant parts of desirable plants. Racer provides control and burndown suppression of annual and perennial broadleaf and grass weeds. Spore producing plants such as mosses and liverworts are also controlled. The amount of burndown and the duration of weed suppression may be reduced when weed growth conditions are unfavorable or when plants are mature.

RACER™ Concentrate is non-volatile and water soluble for foliar application in tractor powered field-type sprayers or manual pump sprayers. Complete and uniform coverage of weeds by the spray solution is required for the best weed control. Plant foliage will change from a green color to brown/black necrotic tissue within one to two hours after spray application of **RACER™ Concentrate** diluted with water. **RACER™ Concentrate** effect on plant tissue may be more rapid in warm weather than in cold conditions. However, weed control is normally unaffected by temperature.

RACER™ Concentrate herbicide is a soap product which penetrates the cell walls of plants to disrupt the cellular organization of physiological functions which are compartmentalized by membranes within the cell walls. Plant growth ceases when cellular contents are mixed which causes brown necrotic plant tissue.

RACER™ Concentrate does not migrate through the soil and is not translocated in plants. **To ensure satisfactory control, plant leaves must be thoroughly and uniformly covered with the spray solution. RACER™ Concentrate** does not provide any residual weed control in soil to affect germinating weed seeds.

Mixing and Application Instructions:

For use, **RACER™ Concentrate** is diluted with water to the specified concentration for effective control of the undesirable vegetation. Apply using standard methods of liquid herbicide application. Dilution must be in accordance with label instructions. Do not apply this product through any type of irrigation system.

A 12% v/v dilution is recommended for most weed control situations and based on the results, applicators may increase or decrease spray concentrations as discussed in the following text and tables to obtain better control or to reduce herbicide use.

The degree of dilution for application is based on the concentration of active ingredient needed for the size of vegetation to be suppressed or the rate of herbicidal effect desired. The larger the vegetation, the higher the concentration (less dilution of Racer Concentrate) required for rapid action. See required concentration for variously sized weeds and grasses in Dosage and Application Rates Section. Hard to control or suppress weeds (perennial weeds and some grasses) may require several applications for complete control.

Spray equipment options include hand-held, boom sprayers, pressure sprayers and hose-end sprayers. Spray nozzles that produce a uniform spray will give maximum coverage of the leaves and improved weed control. **RACER™ Concentrate** is completely soluble in water and when uniformly mixed, no additional mixing or agitation is required.

Application Precautions:

- Do not apply to weeds when wet from dew, rain or irrigation.
- Do not irrigate within 2 hours after application
- Do not apply if rainfall is expected within 2 hours.

During application, some foaming may occur; however, weed control is unaffected if the foam is deposited on the plant surface and is not blown away as drift. Foaming can be reduced by using the minimum spray pressure required for a uniform application to the target weeds. Use low spray pressure to reduce foaming and avoid contact with desirable plants. Most spray nozzles are designed to operate at 10 to 15 psi and provide uniform spray coverage of weeds.

Mixing:

Fill sprayer tank with half the required amount of water, add the full amount of Racer to be used (see Dilution Factors below), then fill the sprayer tank with the remainder of the water required for the desired final concentration. Since **RACER™ Concentrate** is completely soluble in water and when uniformly dispersed in water, continuous mixing or agitation is not required.

Broadcast Application with Field Sprayer Boom Equipment

The amount of weed vegetation will determine the spray volume required for complete coverage of undesired plants (weeds). Weed vegetation conditions that affect spray coverage are number of weeds present, leaf shape, weed size and weed species. For weeds of over 1 inch height do not use less than 30 gal/acre. Large weeds of 12 to 18 inch height may require 80 to 125 gal/acre or more for control.

Hand-Held Equipment

Thorough saturation of the foliage and stems is required for control, but stop sprays when run-off from weed leaves occurs. Use low spray pressure to reduce foaming and avoid contact with desirable plants. Most spray nozzles are designed to operate at 10 to 15 psi and provide uniform spray coverage of weeds.

Directed Spray Equipment

Use a shielded sprayer to prevent spray contact on desirable plants. Avoid spray contact of green plant stems or green bark of young trees and shrubs.

NOTE: In areas of hard water, the final mixture may appear milky. This condition does not change the effectiveness of the treatment. Some visible foam may appear on the leaves as the plants are sprayed. Overspray or drift onto desirable plants is usually not a serious problem because leaves and stems require a thoroughly wet spray coverage for significant injury. Repeat applications as often as necessary to obtain desired control.

Dosage and Application Rates:

For general weed and grass control, rates are based on the size of the plants and/or the desired speed of kill. The larger the plants, the higher the dosage rates needed to ensure maximum herbicidal activity. Also, the higher the concentration, the quicker the plants wilt and turn brown. Apply Racer Concentrate spray solutions only when weed surfaces are dry.

The rate table presents the suggested percent volume/volume solutions of **RACER™ Concentrate** to use for application as follows:

- Use a 6 to 8 % V/V **RACER™ Concentrate** spray solution for control of annual weeds of 1 inch height or less and for control of liverworts and mosses.

- Use an 8 to 10% V/V **RACER™ Concentrate** spray solution for control of annual weeds over 1 inch height and up to 4 inch height.

- Use a 10 to 13% V/V **RACER™ Concentrate** spray solution for weeds over 4 inch height and for hard to control weeds.

- A 15% V/V **RACER™ Concentrate** spray solution is the maximum labeled rate. Use this rate for hard to control perennial weeds or extremely dense weed growth.

Repeat spray applications as necessary to obtain the desired control or suppression of weeds from newly germinated weed seeds and regrowth from roots or stems.

RATE TABLE

Final Spray Volume (gallons)	Amount of Racer for Percent V/V (Volume/Volume) Solution				
	6%	8%	10%	13%	15%
1	8 fl oz	10 fl oz	13 fl oz	1 pt	1.2 pt
2	1 pt	1.3 pt	1.6 pt	2 pt	2.4 pt
5	2.5 pt	3.3 pt	4 pt	5 pt	6 pt
10	5 pt	6.5 pt	1 gal	1.3 gal	1.5 gal
20	1.3 gal	1.6 gal	2 gal	2.6 gal	3.0 gal

Height of Plants to be Controlled	Spray Solution (% V/V)
1 inch or less	6 to 8%
1 to 3 inches	8 to 10%
Above 3 inches	10 to 13%

NOTE: Do not use spray concentrations higher than 15% in a pressure sprayer since unacceptable foaming and bubble formation may occur at the nozzle heads.

Use Methods

Determine the weed control situation and select the use method required as follows:

A. Vegetative Burndown: Broadcast spray for weed control for no-till planting or seedbed preparation to control weeds prior to seeding or transplanting. Spot sprays may be used in crops, ornamentals, pastures and turf.

B. Directed and shielded sprays: Spray nozzle type or configuration for directed spray or a shield placed around the nozzle to prevent spray contact on the foliage or green stems or bark. Directed/shielded spray applications to area between plastic mulch strips and staked crops for weed control.

C. Preemergence Spray Before Seeds Germinate and Emerge, and Before Perennial Plants, Tubers, Bulbs or Seed Pieces Sprout and Emerge: Make application before new growth emerges.

D. Dormant or Post Harvest Spray: Apply after crops are harvested to kill weeds and residual green growth of the crop plants. Apply to dormant crops such as alfalfa or turf.

E. Sucker Control, Pruning and Trimming: Direct sprays to kill small tender basal suckers in crops such as brambles and fruit trees.

F. Desiccation and Harvest Aid: Apply only when crop is ready to harvest and green crop leaves or weeds interfere with harvest. Spray as broadcast application over the crop and weeds for rapid desiccation of green plant growth to facilitate harvest. Apply as an harvest aid for cotton, potatoes and other root, tuber and bulb vegetables.

G. Industrial and Building Uses: Apply to weeds in walkways, driveways, parking areas and around buildings or structures. Broadcast or spot sprays may be applied to open field areas and rights-of-ways.

PESTS

I. Weeds controlled or suppressed by Racer Concentrate:

COMMON NAMES	TAXONOMIC NAMES
Broadleaf Weeds:	
Algae	**Gloeocapsa magma**
Bittercress, hairy	**Cardamine hirsuta**
Chickweed, common	**Stellaria media**
Chickweed, mouse-ear	**Cerastium vulgatum**
Cocklebur, common	**Xanthium strumarium**
Corn spurry	**Spergula arvensis**
Cudweed, purple	**Gnaphalium purpureum**
Groundsel	**Senecio spp.**
Lambsquarters, common	**Chenopodium album**
Liverwort	**Machantia spp.**
Marestail or Horseweed rosettes	**Conyza canadensis**
Morningglory, annual	**Ipomoea spp.**
Moss	**Bryophyta**
Mustards	**Brassica spp.**
Oxalis or Woodsorrel	**Oxalis stricta**
Pansy, wild	**Viola tricolor**
Plantain	**Plantago spp.**
Pigweed, smooth and redroot	**Amaranthus spp.**
Mallow, roundleaved	**Malva spp.**
Moneywort	**Lysimachia nummularia**
Shepherdspurse	**Capsella bursa-pastoris**
Sorrel, sheep	**Rumex acetosella**
Spurge, spotted	**Euphorbia maculata**
Field pennycress	**Thiaspi arvense**
Velvetleaf	**Abutilon theophrasti**
Grass and Other Weeds:	
Bentgrass, colonial	**Agrostis tenuis**
Bluegrass, annual	**Poa annua**
Crabgrass, large	**Digitaria sanguinalis**
Fescue, creeping red	**Festuca rubra**
Fescue, hard	**Festuca ovina**
Nimblewill	**Muhlenbergia scheberi**
Onion, wild	**Allium canadense**
Ryegrass, perennial	**Lolium perenne**
Star-of-Bethlehem	**Ornithogalum nutans**

II. Weeds Moderately Difficult to Control[1]

Bermudagrass (Wireweed)	**Cynodon dactylon**
Bindweed, field	**Convolvulus arvensis**
Dandelion	**Taraxacum officinale**
Nutsedge, yellow	**Cyperus esculentus**
Ragweed, common	**Ambrosia artemisiifolia**

[1] Use 13 to 15% V/V Racer for control or suppression

Crop Uses and Methods of Application*

* Refer to the General Instructions section for Use Methods description

Crop Group	Crops	Use Methods
Root Tuber and Perennial Vegetables	Asparagus, artichoke, beet, carrot, ginger, horseradish, parsnip, potato, radish, rutabaga, sweet potato, turnip and yam [1] Harvest Aid and Desiccation approved for root and tuber crops in this crop group	A, B, C, D, F[1]
Bulb vegetables	Garlic, leek, onion and shallot	A, B ,C, F
Leafy Vegetables	Celery, cilantro, cress, endive, fennel, lettuce, parsley, rhubarb, spinach, Swiss chard	A, B
Cole or Brassica Crops	Broccoli, brussel sprouts, cabbage, cauliflower, collards, kale, kohlrabi, mustard and turnip greens	A, B, C
Legume Vegetables	Beans (Phaseolus spp.: black, green, kidney, lima, mung, navy, pinto, snap and wax), (Vigna spp.: black-eyed, Chinese longbean, cowpea and southern pea), peas (Pisum spp.: garden, green, sugar and snow peas), soybeans	A, B, C
Fruiting Vegetables	Eggplant, okra, pepper, (bell, chili, sweet), pimento, and tomato	A, B, C
Cucurbits and Melons	Cucumber, gourd, muskmelon, cantaloupe, pumpkin, squash, and watermelon	A, B, C
Citrus	Grapefruit, kumquat, lemon, lime, orange, tangerine and tangelo	A, B
Pome Fruit	Apple, crabapple, pear and quince	A, B, E
Stone fruit	Apricot, cherry, nectarine, peach, plum and prune	A, B, E
Small Fruit and Grapes	Blackberry, blueberry, boysenberry, cranberry, currant, dewberry, elderberry, grape (all types), loganberry, olallieberry, raspberry and strawberry	A, B, C, E
Nuts	Almond, brazil nut, chestnut, filbert, macadamia, pecan, pistachio and walnut	A, B, E
Tropical and Other Fruit	Avocado, banana, coconut, date, fig, guava, kiwi, mango, olive, persimmon, papaya and banana	A, B, E
Agronomic Crops and Cereal Grains	Barley, buckwheat, canola, corn (field, popcorn and sweet), cotton, cowpea, flax, millet, oat, peanut, rice, rye, safflower, sorghum, soybean, sugarcane, sunflower and wheat [1] Harvest Aid and Desiccation approved for cotton, soybean and wheat	A, B, C, F[1]
Forages and Pastures (Forage or Seeds)	Alfalfa, clovers, trefoil, vetch, bromegrass, fescue, bluegrass, lespedeza, ryegrass, sudangrass, timothy, range grasses and crops grown for livestock feed	A, C, D
Herbs and Spices	Anise, basil. Caraway, chive, cumin, curry, dill, fennel, oregano, mints, rosemary, sage, savory, sweet bay, tarragon, thyme and wintergreen	A, B, C, D
Beverage and Specialty Crops	Cocoa, coffee, hops, tea, tobacco and jojoba	A, B, E

Non-Crop Uses and Methods of Application*

*** Refer to the General Instructions section for Use Methods description**

Non-Crop Group	Crops	Use Methods
Turf, Flowers, Container, Bedding and Landscape Plants	Turfgrass (maintenance, sod or seed production), bedding plants, flowers and ornamental plants	A, B, C, D, E, F
Trees and Shrubs	Christmas trees, forest and commercial trees, landscape trees, nursery production of trees and shrubs	A, B, E
Greenhouse and Indoor Use	All crops, plants and structures	A, B, C, G
Non-Crop, Industrial, Parks and Public Areas	Farmstead, homestead, fallow land, storage areas, schools, paved areas, rights-of-ways (road, railroad, utilities, etc.), parking lots, recreational areas (athletic fields, campgrounds, golf courses, playgrounds, etc.), walks, industrial sites (tank farms, lumberyard, warehouses and other structures, etc.)	A, B. G
Buildings, Driveways, Walkways and Other Structures	Benches, decks, equipment, floors, roofs, wall, walks and evaporative cooling pads	G
Dry Aquatic Sites, Dry Drainage Systems, and Around Aquatic Sites	Applications must be made 72 hours prior to reflooding of dry aquatic sites. Dry ditches, dry canals, ditch banks, and for use above the water line or after drawdown of agricultural irrigation water and ditch systems, industrial ponds and disposal systems, and impounded water areas.	A, G

Terms and Conditions of Use:

If terms of the following Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies are not acceptable, return unopened package at once to the seller for a full refund of purchase price paid. Otherwise, use by the buyer or any other user constitutes acceptance of the terms under Warranty Disclaimer, Inherent Risks of Use and Limitations of Remedies.

Warranty Disclaimer Notice:

To the extent consistent with applicable law, Falcon Lab, LLC, makes no warranty or guarantee of any kind, expressed or implied concerning the effects of use of this product, other than those specified on this label and subject to the inherent risks set forth below. Buyers or users accept all responsibility for results due to misuse or improper handling of this product.

Inherent Risks of Use:

It is impossible to eliminate all risks associated with use of this product. Crop injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to the label instructions (including adverse conditions noted on the label, such as unfavorable temperatures, wind, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of Falcon Lab, LLC or the seller. All such risks shall be assumed by the buyer.

Limitation of Remedies:
The exclusive remedy for losses or damages resulting from the use of this product (including claims based on contract, negligence, strict liability, or other legal theories), shall be limited to, at Falcon Lab, LLC's election, one of the following:

1. Refund of purchase price paid by buyer or user for product bought, or
2. Replacement of amount of product used.

To the extent allowable by state law, Falcon Lab, LLC shall not be liable for losses or damages resulting from handling or use of this product unless Falcon Lab, LLC is promptly notified of such loss or damage in writing. In no case shall Falcon Lab, LLC be liable for consequential or incidental damages or losses.

The terms of the Warranty Disclaimer above and this Limitation of Remedies cannot be varied by any written or verbal statements or agreements. No employee or sales agent of Falcon Lab, LLC or the seller is authorized to vary or exceed the terms of the Warranty Disclaimer or this Limitation of Remedies in any manner.

Produced for:
Falcon Lab LLC
1103 Norbee Drive
Wilmington , DE 19803-4123
302-764-0392
www.falconlabllc.com

EXHIBIT O

FALCONLAB
Environmentally friendly chemistry

Racer® Concentrate

MATERIAL SAFETY DATA SHEET

Date of Issue: March 4, 2008

SECTION 1 - MATERIAL IDENTIFICATION

Trade Name:	**Racer® Herbicide Concentrate**
Active Ingredients(a.i.):	Ammonium nonanoate
Formula:	$C_9H_{21}NO_2$ (ammonium nonanoate)
Chemical Family:	Salts of fatty acids, soap
Chemical Use:	Herbicide for the control of unwanted vegetation.
a.i. CAS#	63718-65-0

SECTION 2 - PHYSICAL DATA

Appearance:	Slightly cloudy to clear pale yellow liquid
Odor:	Low characteristic
Boiling Point:	220° F (104.4° C) with decomposition.
Melting Point:	Does not freeze.
Specific Gravity:	0.99@68° F (20° C),
Solubility in water:	Completely miscible in all proportions
Solubilty in organic liquids:	Moderate solubility in acetone and alcohol, insoluble in esters and aliphatic and aromatic hydrocarbons.
pH:	7-8.5 (neutral to slightly basic)
Viscosity:	61 cps. (74° F)

SECTION 3 - FIRE AND EXPLOSION DATA

Flash Point:	Does not have a flash point.
Extinguishing Media:	Does not burn.
Special Fire Fighting Procedure:	None required.
Unusual Fire and Explosion Hazard:	None

SECTION 4 - STABILITY AND REACTIVITY

Chemical Stability:	Material is stable and does not decompose or change in chemical composition during storage. Not corrosive to steel and can be stored in glass, steel, plastic lined steel or polyethylene containers. Solid ammonium salts may form around bottle caps or other storage lids. This non-hazardous residue can be washed off with water allowing the rinse water to enter a sewer system.
Conditions to Avoid:	Storage temperatures below 32° F (0° C). This will cause solid a.i. to crystallize from solution thus changing the concentration of the product and possibly bursting storage container.
Incompatible Materials:	Acids and strong bases and any material incompatible with water.
Decomposition Products:	Steam, ammonia gas and fatty acid decomposition products may be produced at temperatures above the boiling point such as would occur in a general conflagration caused by other factors.
Hazardous Polymerization:	Will not occur.

SECTION 5 - HEALTH HAZARDS

Primary Route of Entry:	Inhalation, oral and eye.
Inhalation:	May cause nose, throat and lung irritation on prolonged exposure to spray. Inhalation of spray should be minimized. No exposure limit established.
Skin Contact;	May cause skin irritation in some people but no cases are known.
Eye Contact:	Causes eye irritation. Goggles, face shield or safety glasses with sideshields must be used during application.
Sensitization:	Ammonium nonanoate is not a dermal sensitizer.
Corrosivity:	Not corrosive except to aluminum or zinc (neutral pH).
Toxicity:	None of the components of this product are listed as carcinogenic by NTP, IARC, or OSHA. The parent acids are non-mutagenic by the Ame's test.

Acute Studies:

Oral LD_{50} (Rats)	>5000 mg/kg (low toxicity)
Dermal LD_{50} (Rabbit)	>5000 mg/kg (low toxicity)
Inhalation LC_{50} (Rat)	>1.244 mg/L (8 hr.) (low toxicity)
Eyes (Rabbit)	91 mg. (Severe irritation)

SECTION 6 - FIRST AID

Eye Contact: Immediately flush with plenty of water for at least 15 minutes Get medical attention.

Skin Contact: Immediately remove contaminated clothing and shoes. Flush exposed areas with water for at least 5 minutes. Use soap if available or follow by washing with soap and water. Do not use contaminated clothing until after laundering. Get medical attention if skin irritation occurs.

Inhalation: Avoid breathing spray mist Move away from sprayed area to fresh air. Get medical attention if breathing does not return to normal in fresh air. Since spray has a pungent, unpleasant odor, there is an odor warning as to when to move to safe area.

Ingestion: Have victim drink one to two glasses of water if conscious. and seek medical attention. Inform medical personnel of type of hazard. i.e. ingested material is fatty acid. If unconscious, get medical attention immediately.

SECTION 7 - ACCIDENTAL RELEASE MEASURES

Protective Measures: Do not handle in confined spaces without adequate ventilation to avoid breathing vapors. If inadequate ventilation, use suitable respirator. Avoid contact with eyes and skin by wearing personal protective equipment.

Spill Management: Stop source of leak if safe to do so. Wash down all spillage with water spray, if possible, allowing wash water to enter sewer system. If in area where water cleanup is not possible, clean up residue with clay, sand or other absorbant material and place in suitable containers for proper disposal based on applicable federal, state and local procedures.

Emergency Information: Available 24 hours/day at CHEMTREC at 800-424-9300

SECTION 8 - SPECIAL HANDLING

Store in cool, dry place. Containers do not have to be grounded when material is transferred from metal drums but it is recommended as a good practice. Transfer in areas with adequate ventilation.

SECTION 9 - SPECIAL PRECAUTIONS

Natural bodies of water: **Racer® is a soap. All soaps are known to be toxic to invertebrates. Do not allow Racer® to enter any natural bodies of water including ponds, streams, lakes or any drainage ditchs leading to such bodies of water.**

Respiratory Protection: Avoid breathing spray mist. Use NIOSH approved respiratory protection for organic vapors in situations where breathing spray may be unavoidable.

Protective Gloves: Utilize appropriate impervious chemical gloves such as barrier laminate, nitrtile rubber or neoprene rubber

Eye Protection:	**Use safety goggles or safety glasses with side shields.**
Storage:	Store in dry area inaccessible to children. Keep container closed when not in use. May be transferred to other containers using protective equipment (see Section 5 above).
Container Disposal.	Empty containers should be rinsed with water and disposed of by recycling, if possible. Wash water should go in sewer system. Otherwise, place container in trash and do not reuse.
Disposal of partially empty Containers:	Fill container with water and pour into sewage system. Wash and dispose of container as above.

SECTION 10 - SHIPPING REGULATIONS

DOT Shipping Name:	None
DOT Shipping Class	None
DOT Label:	None
Freight Classification:	Compounds, Herbicides, N.O.I. NMFC 50320, Class 60

HMIS Hazard Rating

Health	2	4 = Extreme
Fire	0	3 = High
Reactivity	1	2 = Moderate
		1 = Slight
		0 = Least

Disclaimer

The information contained in this MSDS is based on technical data that Falcon Lab LLC believes to be reliable and is provided to our customers at no cost. It is intended for use by persons having technical skill and at their own discretion and risk. Falcon Lab will assume no liability in connection with any uses of this information and no warranties, expressed or implied, are made with this information since conditions of use are outside Falcon Lab's control.

Falcon Lab LLC
1103 Norbee Drive
Wilmington, De 19803

302-764-0392

www.falconlabllc.com

Front Container label

EXHIBIT P Company

Container label

FALCON LAB
Environmentally friendly chemistry

RACER™
Concentrate
Non-selective Herbicide

FOR ORGANIC PRODUCTION

FOR AGRICULTURAL AND COMMERCIAL USE

FOR CONTACT SPRAY CONTROL OR BURNDOWN OF WEEDS AND GRASSES FOR FOOD CROPS, FIELD CROPS, PASTURES, ORNAMENTALS, TURF, LANDSCAPES, INTERIORSCAPES, GREENHOUSES, NON-CROP AREAS ON FARMSTEDS AND AROUND BUILDINGS AND INDUSTRIAL SITES

KEEP OUT OF REACH OF CHILDREN

WARNING "AVISO"

"Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)"

Active ingredient:	
Ammonium Nonanoate	40.0 wt.%
Other ingredients	60.0 wt.%
Total	100.00 wt.%

RACER™ Concentrate contains 3.3 lbs. of ammonium nonanoate per US gallon

EPA Reg. No.79766-1

EPA Establishment No.79766-
This product is protected by U. S. Patent No. 6,323,156

Net Contents: 1 pint (16 fl. oz.)

LABELING ACCEPTABLE
STATE OF CALIFORNIA
DEPARTMENT OF PESTICIDE REGULATION
[illegible]
5/27/09 [illegible] Rhodes
79766-1-AA

Exhibit Q

Florida Pesticide Registration Form EF-1

PRODUCT CHEMISTRY SUMMARY

Product/Brand Name: RACER™ EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

Structure: $CH_3(CH_2)_7COO^- \ NH_4^+$

pH: 7 – 7.5 (neutral to slightly basic).

Vapor Pressure: 760 mm/Hg at 1 atm. (same as water)

Melting Point: Liquid solution. Solid a.i. may form when solution is below 0° C.

Specific Gravity: 1 gm./ml.; 8.32#/gal, same as water.

Octonal/water Partition Coefficient: Not applicable.

Water Solubility: Completely miscible in all proportions.

Empirical Formula: $C_9H_{21}NO_2$

Molecular Weight: 175

KOC:

KD:

Oxidizing or Reducing Action: None.

Corrosion Characteristics: Not corrosive to any plastic materials or iron (steel). May corrode aluminum and zinc due to basic pH.

Flammability: Not flammable.

List of impurities associated with active ingredient: Ammonium octanoate (C_8 salt) and ammonium decanoate (C_{10} salt)

Florida Pesticide Registration Form EF-2

LEACHING AND ADSORPTION/DESORPTION STUDIES

Product/Brand Name: RACER™ EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

Falcon Lab is unaware of any studies of the absorption/desorption of soap in soil.

Such studies appear unnecessary due to the fact that calcium, magnesium, aluminum, iron and other metal salts of fatty acids are very water insoluble. Thus, when soap solutions, such as RACER, contact any type of soil, whether sand, clay or other earth media, exchange of cations will occur leading to water insoluble fatty acid salts. Such salts do not migrate but are held in place due to their water insolubility.

The primary environmental degradation route of these fatty acids (and their derivatives) is by microbial action and not by hydrolysis. Studies submitted to the EPA indicate that the half-life of fatty acids in the environment is approximately less than one day (*RED, p. 10*)

Florida Pesticide Registration Form EF-3

HYDROLYSIS STUDIES

Product/Brand Name: RACER^{TM} EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

Since RACER^{TM} is a salt, the reaction product of an acid and a base, it does not hydrolyze.

"Hydrolysis of potassium salts of fatty acids was shown not to occur over a period of 43 days. This is consistent with the literature on fatty acids... Due to the similarity of chemical structure, it is expected that hydrolysis of the ammonium salts of fatty acid would be similar to that of the potassium salts of fatty acids." (Cited on p. 10, RED)

Florida Pesticide Registration Form EF-4

PHOTODEGRADATION STUDIES

Product/Brand Name: RACER^{TM} EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

Fatty acids and their salts do not photodegrade.

Fatty acids are so-called aliphatic acids made up of connected carbon atoms in a straight line and as many hydrogen atoms attached to each carbon as allowed under the laws of chemistry (saturated compounds). Such compounds do NOT absorb visible or UV light. Thus, no energy is provided to cause bond cleavage and degradation.

Since the a.i. in RACER is a solid salt, its vapor pressure is very low and the chance of entering the atmosphere where it may be attacked by hydroxyl radicals is very low, photodegradation in the atmosphere is remote. However, if such degradation were to occur, the degradation products would be lower aliphatic alcohols that would further degrade to carbon dioxide and water.

Florida Pesticide Registration Form EF-5

AEROBIC SOIL METABOLISM STUDIES

Product/Brand Name: RACER™ EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

"The available data indicate that all fatty acid salt chain lengths up to and including C18 can be metabolized under aerobic conditions and can be considered to be readily biodegradable" (HERA, p. 11), *(BKH (1994) Environmental data review of soaps. NVZ in cooperation with European surfactant industry. Delft, The Netherlands.*

" Studies submitted to the Agency (EPA) indicate that the half-life of these fatty acids is approximately less than one day *(Mozo; et. al. "Degradation of Fatty Acids of Lawn Soil" and "Fate of Capric and Pelargonic acids in soil" (1991).* As can be expected, there is very rapid microbial degradation of fatty acids in soil…The active ingredient cannot totally dissipate from soil, because there is a natural content of fatty acids in soil resulting from plant metabolism and by formation of microbial organisms.*(RED – Soap Salts, p. 10, EPA (1992).*

See also:
http://www.nicnas.gov.au/publications/car/new/na/nafullr/na0100fr/na114fr.pdf

Florida Pesticide Registration Form EF-6

ANAEROBIC SOIL METABOLISM STUDIES

Product/Brand Name: RACER™ EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

Both calcium and sodium salts of fatty acids have been shown to exhibit significant removal under anaerobic conditions. Since ammonium salts will be converted to calcium salts under virtually all conditions involving contact with earth or animal debris, then this data can be applied to RACER a.i. This is discussed and data shown in tabular form in the HERA report on p.19 *(BKH) Environmental data review of soaps. NVZ in cooperation with European surfactant industry. Delft, The Netherlands,1994*

The degradation half-life of soaps under anaerobic conditions in sludge-amended soils was determined to be 36 days. *This is also discussed on p. 22 of HERA (Prats, et. al., Biodegradation of soaps in anaerobic digesters and on sludge amended soils.(Proceedings of the 4th world surfactants congress. Barcelona, 3-7VI:81-86, CESIO, 1996).*

Florida Pesticide Registration Form EF-7

AEROBIC AQUATIC METABOLISM STUDIES

Product/Brand Name: RACER^{TM} EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

"The fate of fatty acid salts in aqueous systems is complicated by the fact that there are a number of water soluble and water insoluble groups and combinations of these. In practice whilst the use of sodium salts are by far the most common use of soap in finished products (*sodium salts like ammonium salts are water-soluble*), the predominance of calcium and magnesium ions in waste water leads to rapid formation and predominance of relatively insoluble Ca and Mg salts (*Swisher R.D., Surfactant Degradation, 2nd. Ed., 1987, Marcel Dekker; (BKH) Environmental data review of soaps. NVZ in cooperation with European surfactant industry. Delft, The Netherlands,1994*

Some of the conclusions drawn from reviews are that the rate of degradation is mainly dependent on the physical and chemical characteristics of the salts and that the fate is strongly influenced by the poor water solubility of the calcium and magnesium salts. A study of fatty acid salts using the Warburg technique indicate that oxidation exceeded 50% ThOD in many cases within 6 -24 hours. (HERA, p. 11)

Florida Pesticide Registration Form EF-8

ANAEROBIC AQUATIC METABOLISM STUDIES

Product/Brand Name: RACER™ EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

See EF-7.

"The fate of fatty acid salts in aqueous systems is complicated by the fact that there are a number of water soluble and water insoluble groups and combinations of these. In practice whilst the use of sodium salts are by far the most common use of soap in finished products (*sodium salts like ammonium salts are water-soluble*), the predominance of calcium and magnesium ions in waste water leads to rapid formation and predominance of relatively insoluble Ca and Mg salts. (*Swisher R.D., Surfactant Degradation, 2nd. Ed., 1987, Marcel Dekker; (BKH) Environmental data review of soaps. NVZ in cooperation with European surfactant industry. Delft, The Netherlands,1994*

Since soluble soaps such as the a.i. in RACER will invariably form water-insoluble calcium and magnesium salts in natural water bodies, no decomposition to other degradation products occur. The insoluble calcium and magnesium salts formed are likely adsorbed in the soil surrounding the bodies of water where they serve as energy sources to various bacterial species, both aerobic and anaerobic. The ultimate fate of the fatty acid salts is carbon dioxide and water.

Florida Pesticide Registration Form EF-9

FIELD DISSIPATION (soil)

Product/Brand Name: RACER^{TM} EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

The ammonium salt a.i. in RACER does not dissipate in the soil due to the fact that it almost immediately forms water-insoluble calcium, magnesium, iron, aluminum and other metal salts. This occurs rapidly enough to prevent any of the RACER a.i. from reaching the roots of the treated vegetation. Thus, RACER does not migrate in the soil and can be used next to trees, grapevines, etc. without damaging the tree or vines.

Florida Pesticide Registration Form T-1 (Formulation)

ACUTE ORAL, DERMAL, INHALATION TOXICITY STUDIES

Product/Brand Name: RACER^{TM} EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

Oral exposure to soaps is generally self-limiting because the taste of soap is easily recognized and unpleasant. The ammonium soap salts also have a notable unpleasant odor that is inhalation limiting. Both the oral LD_{50} and dermal LD_{50} reported for soap salts by the EPA in "*RED –Soap Salts*" is Category IV.

Since the stomach of all animals and humans is strongly acidic, the oral ingestion of ammonium nonanoate will result in the formation of nonanoic acid by the reaction with stomach acid. Undiluted nonanoic acid administered orally to rats at a dose of 3,200 mg/kg did not cause death of any of the rats, which indicated an LD_{50} of over 3,200 mg./kg. Nonanoic acid of unspecified source administered orally to rats and mice had an LD_{50} of 5,000 mg/kg for both rat and mouse. For male rats, the oral LD_{50} was >9,000 mg/kg. *(*Fed. Reg. Vol. 6, No. 52, p.12672*)*

The dermal LD_{50} for undiluted nonanoic acid in rabbits has been reported to be 5,000 mg/kg. Nonanoic acid from an unspecified source caused a dermal LD_{50} of 2,000 mg/kg on rats.

Nonanoic acid was delivered at 0.46 mg/liter as an aerosol for 4 hours without any mortality. Like oral exposure, inhalation exposure is self-limiting due to the odor and irritating effect caused by the breathing of diluted RACER spray. (Ibid.)

Rats exposed to atmospheric concentrations of 840 mg/m^3 (125 ppm) for a period of 6 hrs showed no symptoms of toxicity. In another study, test animals were subjected to an atmospheric concentration of 1150 ppm for a period of 6 hrs. Clinical signs were nasal discharge, blinking and labored breathing. (Toxicity Report, Pelargonic Acid, Lab. of Ind. Med., Eastman Kodak Co., 1959

Florida Pesticide Registration Form T-1 (Technical)

ACUTE ORAL, DERMAL, INHALATION TOXICITY STUDIES

Product/Brand Name: RACER^{TM} EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

See T-1 (Formulation). Attached are the MSDS's for the starting materials for RACER^{TM} There is no difference between the technical product and the final product.

Florida Pesticide Registration Form T-2

PRIMARY EYE, DERMAL IRRITATION STUDIES

Product/Brand Name: RACER^{TM} EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

In a study conducted by Falcon Lab at Product Safety Laboratories, Dayton, NJ in December 2005 with Racer Concentrate (40 wt. % ammonium nonanoate) on rabbits, the conclusion of the investigators was: "Under the conditions of this study, RACER^{TM} Herbicide Concentrate is classified as severely irritating to the eye". This study is in Falcon Lab files and the entire report is available on request.

TOXNET reports the following under "Nonanoic acid and its common salts": "Nonanoic acid was a skin irritant in humans, rabbits and guinea pigs and caused eye irritation in rabbits" <www.nlm.nih.gov/pubs/factsheets/toxnetfs.html>

"Application of nonanoic acid to intact and abraded skin of rabbits had an LD_{50} of 9,000 mg/kg and caused moderate to severe irritation. *(Fed. Reg. Vol. 69, No. 52, p. 12672.)*

Florida Pesticide Registration Form T-3

SKIN SENSITIZATION STUDIES

Product/Brand Name: RACER^{TM} EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

No studies have been made on potential skin sensitization of ammonium nonanoate. However, the EPA reports that the skin effects of soap salts are mild – moderate irritation and non-sensitizing. (RED, pg. 7).

Florida Pesticide Registration Form T-4

CHRONIC FEEDING/ONCOGENICITY STUDIES

Product/Brand Name: RACER^{TM} EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

Animal or human Ingestion of ammonium nonanoate would immediately result in the formation of nonanoic acid in the stomach. Thus, nonanoic acid feeding results would be the same as the ingestion of the ammonium salt.

In an oral toxicity study (conducted for 14 days), no systemic toxicity was observed for either sex (animal species unspecified) even at the highest nonanoic acid dose tested, 20,000 ppm (1,834 mg/kg/day). In addition, nonanoic acid showed no adverse effects on survival, clinical signs, body weight gain, food consumption, hematology, clinical chemistry or gross pathology. The EPA determined that because no toxic effects were observed at a very high level dose approaching 2,000 mg/kg, a 90 day oral study was not necessary. (68 FR 7931)

Nonanoic acid was weakly positive for inducing mutations in mouse lymphoma cells. Mutations were induced at greater than or equal to 50 [mu] g/ml. Since the mutations were observed with severe cytotoxicity and small colony development, the observed mutations may have been an aberration caused by cell damage and not actual mutational changes (61 FR 5716)

It was reported that the Ames test (Salmonella/reverse mutation assay) showed nonanoic acid to be non-mutagenic. Similarly, an in-vivo cytogenetics study using micronucleus assay gave a negative result. (68 FR 7931)

Florida Pesticide Registration Form T-5

TERATAGENICITY STUDIES

Product/Brand Name: RACER™ EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

Ammonium nonanoate when fed to animals will be converted immediately to nonanoic acid by the animal's stomach acid.

Development toxicity was conducted on a group of 22 pregnant Crl: COBS CD(SD) BR rats. These rats were treated with nonanoic acid in corn oil at a dose of 1,500 mg/kg on gestation days 6 through 15 (both days inclusive). Maternal body weight was not significantly affected during the treatment. Only 1 out of 22 animals showed signs of clinical toxicity. No significant histopathology signs were observed in the maternal animals. Nonanoic acid treatment did not have any significant effect on cesarean section observations. Four fetuses in one litter showed a higher incident of cleft palate compared to the control mean. For maternal toxicity, EPA determined the no observed adverse effect level (NOAEL) to be greater than 1,500 mg/kg/day. EPA has determined that this dose is in excess of the Agency's limit dose for toxic effects. The type and level of exposure expected from the active ingredient use of this chemical is much lower than the dose level shown in the study (68 FR 7931).

Florida Pesticide Registration Form T-6

MULTI-GENERATION REPRODUCTIVE STUDIES

Product/Brand Name: RACER™ EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

There appears to be no need for multi-generational reproductive studies of nonanoic acid salts since the outcome is predictable based on the EPA study that showed no evidence of reproductive or developmental toxicity in rats treated orally during pregnancy (See T-5).

Florida Pesticide Registration Form T-7

ACUTE DELAYED NEUROTOXICITY STUDIES

Product/Brand Name: RACER™ EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

No known studies of this nature have been conducted on soap salts, ammonium nonanoate or nonanoic acid. However, it appears very unlikely that fatty acids are neurotoxins since naturally occurring fatty acids constitute a significant part of the normal daily diet of humans, (including nonanoic acid) They are of low toxicity when taken orally and pose no known health risk.

Florida Pesticide Registration Form T-8

90-DAY FEEDING STUDIES

Product/Brand Name: RACER™ EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

The 90-day oral toxicity study on pelargonic (nonanoic) acid was waived by the EPA on the strength of the absence of toxic effects at or below a limit dose (1,000 milligrams/kilogram/day (mg/kg/day)) in the 2-week range finding and developmental toxicity test results. *(Fed. Reg. Vol. 63, No. 205, p. 56882-5688, 1998)*

Florida Pesticide Registration Form T-10

ACUTE AVIAN ORAL TOXICITY STUDIES

Product/Brand Name: RACER^{TM} EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

An LD_{50} greater than 2,000 mg/kg was determined for bobwhite quail given a single dose of soap salts. An LD_{50} greater than 2,510 mg/kg was determined for mallard ducks. Therefore, soap salts can be considered relatively non-toxic to bobwhite quail and mallard duck on an acute oral basis. (RED, p. 15)

The available toxicity data do not indicate a requirement of precautionary labeling for birds on products containing ammonium salts of fatty acids. (RED, p.11)

Florida Pesticide Registration Form T-11

AVIAN DIETARY LC_{50} Studies

Product/Brand Name: RACER™ EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

The results of 8-day dietary studies indicate that the LC_{50} for ammonium salt soaps is greater than 5,000 ppm for both mallard ducks and bobwhite quail. The available data indicate that ammonium salts of fatty acids are practically non-toxic to upland game birds and waterfowl. (RED, p.11)

Florida Pesticide Registration Form T-12

ACUTE LC_{50}: FISH, FRESHWATER INVERTEBRATES AND MARINE ORGANISMS

Product/Brand Name: RACER™ EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

No studies on the effect of ammonium salts of fatty acids on fish have been found in the literature. “However, a tentative position can be taken that because of the similarities of soap salts, the potassium salts of fatty acids can probably be substituted for ammonium salts of fatty acids” (RED, p. 12).

Two tests were performed on freshwater fish using the potassium salt technical grade material. The LC_{50}'s were determined to be 18.06 ppm and 35.35 ppm for trout and bluegills respectively. One study with the typical end-use product performed on fathead minnows produced a LC_{50} of 21 ppm. These data indicate that potassium soap salts, and by presumption, ammonium soap salts, are slightly toxic to both coldwater and warmwater fish species. (RED, p.13).

The core study for potassium soap salts indicates that potassium soap salts are highly toxic (LC_{50} = 0.57 ppm) to freshwater invertebrates, thus ammonium soap salts are also likely to be highly toxic to invertebrates. However, all soluble soaps will quickly react with any calcium, magnesium and iron ions in the water to produce insoluble matter that would not be expected to be toxic to invertebrates.

Toxicity to algae may be estimated by comparison with soaps in general. For example, an LC_{50} range of 180-320 mg/L has been reported for Chlorella vulgaris. Therefore, nonanoate salts would not be expected to be significantly toxic to algae (Fed. Reg., Vol. 69, No. 52, p. 12673, 2004)

Florida Pesticide Registration Form

BIOACCUMULATION
(aquatic organisms)

Product/Brand Name: RACER^{TM} EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

Since nonanoic acid occurs naturally in both plants and animals, it is likely that aquatic organisms, like other microflora, use fatty acids in their environment as a source of energy, Thus, bioaccumulation of such materials is desirable. Water invertebrates also consume fatty acids as a normal constituent of their daily diet (RED, p. 10)

Florida Pesticide Registration Form

BIOACCUMULATION
(fish)

Product/Brand Name: RACER^{TM} EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

Fish are an important source of essential fatty acids in the human diet and are recommended by nutritionists to be included as part of a health diet. All fish supply fatty acids, some more than others. The most abundant source of most nutrients leading to the formation of fish fatty acids is algae, although other sources such as fatty acids in the water contribute. Thus, fatty acids in water are consumed by the fish as a normal part of their daily diet, just the same as mammals and birds. Bioaccumulation in fish is desirable.

Florida Pesticide Registration Form CR-1

CHEMICAL RESIDUE METHODS AND STANDARDS

Product/Brand Name: RACER^{TM} EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

As stated on the suggested Form CR-1, the purpose of the form is to supply an analytical method useful for monitoring the use of RACER within Florida. However, for the following reasons, such a procedure is not feasible.

- "Residues from fatty acid salt residues are not likely to exceed levels of naturally occurring fatty acids in commonly eaten foods." (*RED, p.9*) Thus, any analytical method used would not be able to distinguish between naturally occurring ammonium nonanoate and that applied as a pesticide.

- "Studies submitted to the EPA indicate that the half-life of these fatty acids is approximately less than one day. As can be expected there is very rapid microbial degradation of fatty acids in soil." (RED, p.10). Since fatty acids degrade rapidly, by the time samples taken for analysis were analyzed, unless done immediately in the field, they would not be representative of the actual amount of ammonium nonanoate present at the time the samples were taken. No such fast analysis is known, or if known, would not be of any value because of the rapid biodegradation of the fatty acid salt being analyzed.

RACER^{TM} Quality Control Method of Analysis

A 100 ml (or 100 g.) aliquot of RACER Concentrate is measured out in a small beaker to which is added 10 ml. of con. hydrochloric acid with stirring. The mixture is poured into the 100 ml. graduated cylinder and allowed to stand until two distinct liquid phases settle out. The lower phase (nonanoic acid) which will be measure approximately 37 ml. is separated in a separatory funnel and weighed. The weight of the nonanoic acid should be 37 ± 0.2 g. A positive identity of the nonanoic acid can be confirmed by FT-IR analysis or by a method obtained from Norm Cook, Antimicrobials Division, Office of Pesticide Programs, U.S. Environmental Protection Agency, 1200 Pennsylvania Ave. Washington, D.C. 20460-0001(68 FR 7931) (FRL -7278-7)

Formation of Ammonium Nonanoate in Nature

Nonanoic acid is naturally present in nature. For example it has been detected and measured in apples at levels up to 224 ppb, 385 ppm in the skin of grapes and 143 ppm in grape pulp. It is present in a number of other foods as well. It also is produced by the normal degradation of higher fatty acids and by the oxidation of oleic acid in the atmosphere.

Ammonia in the environment is a part of the nitrogen cycle and is in the gaseous decomposition products of all animal waste. The principle form of ammonia in the atmosphere is as NH_3 (a gas), not as the ammonium ion (NH_4^+) which is not gaseous and exists only in water. When an acid such as nonanoic acid comes in contact with a base such as gaseous ammonia (or ammonium ion in water), neutralization (the reaction between an acid and a base) rapidly takes place forming the ammonium salt of nonanoic acid. This reaction takes place with all acids found in nature, so ammonium salts of all natural acids are ubiquitous. (*TOXNET, Environmental Health Criteria, 54 (1986), p. 210*)

Florida Pesticide Registration Form

FIELD DISSIPATION
(aquatic sediment)

Product/Brand Name: RACER^{TM} EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

The EPA labeling of RACER^{TM} does not permit its use on or near water. Should the active ingredient, ammonium nonanoate, be accidentally distributed into ponds, streams or other similar bodies of water, it will react with calcium, magnesium, iron and other soluble metal ions in the water to produce water insoluble materials that will either be carried with the stream as insoluble particles or more likely settle out on the soil on the bottom and banks of the body of water. Fatty acids are known to rapidly degrade by microbial action. "Microbial metabolism of fatty acids has the effect of either converting the carbon content of the fatty acid to any of the thousands of naturally occurring organic substances produced by the soil microflora (if used as an energy source)." (RED, p.10)

Florida Pesticide Registration Form

GENERAL METABOLISM

Product/Brand Name: RACER™ EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

"Fatty acids are normally metabolized by the cells, where they are oxidized to simple compounds for use as energy sources and as structural components utilized in all living cells. Potassium, sodium and ammonium are normally part of the body's metabolism and electrolytic balance." (*RED, p. 8).*

Nonanoic acid, as a straight chain carbon molecule, would be metabolized by beta-oxidation to form acetate molecules that enter the citric acid cycle and are metabolized to carbon dioxide, water and energy. None of the metabolites would be considered to have any toxicological risk since they are the same metabolites produced by the metabolism of all fats consumed daily by humans. *(Fed. Reg., Vol. 69, No. 52, p. 12674, March 17, 2004)*

Florida Pesticide Registration Form

MUTAGENICITY

Product/Brand Name: RACER™ EPA Reg. No. : 79766-1

Active Ingredient Chemical Name: Ammonium nonanoate

Active Ingredient Common Names: Ammonium pelargonate,

"DNA inhibition was reported with 600 umol/l of the sodium salt of caprylic acid (10 carbon), tested with guinea pig kidney cells. Unscheduled DNA synthesis was found in mouse cells with 35 mg/kg of oleic acid. Cytogenetic analysis was positive for 2500 ug/L of oleic acid with hamster fibroblasts and for 100 mg/l with *Saccharomyces cerevisiae" (RED, p.8).*

Fatty acids are negative in *in vitro* bacterial systems used in the Ames test. In addition, saturated fatty acids up to and including C_{12} and the unsaturated acid, oleic acid, have shown inhibition of the mutagenic activity of N-nitrosodialkylamines on *Eschericha coli.* (*HERA, Fatty Acid Salts, June 2002, p. 23).*

Capric acid (C_{10}) produced negative results in the Ames test using *Salmonella typhimurium* strains TA97, TA98, TA100, TA1535 and TA1537 at concentrations ranging from 0 - 666 µg/plate, with and without metabolic activation. (*HERA, Fatty Acid Salts, June 2002, p. 23).*

Florida Department of Agriculture & Consumer Services
CHARLES H. BRONSON, Commissioner

Please Respond To:

Mr. Charlie L. Clark
Bureau of Pesticides/Pesticide Registration Section
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AUGUST 10, 2007

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THIS IS CONFIRMATION THAT THE FOLLOWING 1 PRODUCT BRAND(S) HAVE BEEN REGISTERED BY FLORIDA.

NOTE: ALL PERMITS AND REGISTRATIONS EXPIRE ANNUALLY ON DECEMBER 31ST AND MUST BE RENEWED FOR THE NEW YEAR BY PAYMENT OF THE APPLICABLE FEES AS REQUIRED UNDER CHAPTER 487, FLORIDA STATUTES.

FIFRA SECTION 18 EMERGENCY EXEMPTION PETITIONS ARE NOT SUBJECT TO STATE REGISTRATION FEES, BUT ARE LISTED WITH OTHER PRODUCT BRANDS IN THE SYSTEM FOR AUDITING PURPOSES.

PRODUCT BRAND NAME	FL/EPA REG NO	EFFECTIVE DATE	EXPIRATION DATE
RACER CONCENTRATE NON-SELECTIVE HERBICIDE	79766-1	08/10/2007	12/31/2007

Late Fees - Changes to Chapter 487.041 Florida Statute:
All renewals for 2008 must be received before January 31, 2008. Renewals received on or after February 1, 2008 will be assessed a late fee of $25 per product brand per month. Renewals will not be processed until all applicable registration and late fees are received.

Weed Technology 2009 23:431–437

Weed Management—Techniques

Efficacy Comparison of Some New Natural-Product Herbicides for Weed Control at Two Growth Stages

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There is an urgent need to accelerate the development and implementation of effective organic-compliant herbicides that are environmentally safe and that help the producer meet increasing consumer demand for organic products. Therefore, greenhouse experiments were conducted to evaluate the effectiveness of acetic acid (5%), acetic acid (30%), citric acid (10%), citric acid (5%) + garlic (0.2%), citric acid (10%) + garlic (0.2%), clove oil (45.6%), and corn gluten meal (CGM) compounds as natural-product herbicides for weed control. The herbicides were applied to the broadleaf weeds stranglervine, wild mustard, black nightshade, sicklepod, velvetleaf, and redroot pigweed and to narrowleaf weeds crowfootgrass, Johnsongrass, annual ryegrass, goosegrass, green foxtail, and yellow nutsedge. The herbicides were applied POST at two weed growth stages, namely, two to four and four to six true-leaf stages. CGM was applied PPI in two soil types. Citric acid (5%) + garlic (0.2%) had the greatest control (98%) of younger broadleaf weeds, followed by acetic acid (30%) > CGM > citric acid (10%) > acetic acid (5%) > citric acid (10%) + garlic (0.2%), and clove oil. Wild mustard was most sensitive to these herbicides, whereas redroot pigweed was the least sensitive. Herbicides did not control narrowleaf weeds except for acetic acid (30%) when applied early POST (EPOST) and CGM. Acetic acid (30%) was phytotoxic to all broadleaf weeds and most narrowleaf weeds when applied EPOST. Delayed application until the four- to six-leaf stage significantly reduced efficacy; acetic acid was less sensitive to growth stage than other herbicides. These results will help to determine effective natural herbicides for controlling weeds in organic farming.

Nomenclature: Acetic acid; citric acid; citric acid (5%) + garlic (0.2%; Alldown); citric acid (10%) + garlic (0.2%; Groundforce); clove oil (45.6%; Matran II); corn gluten meal (CGM); annual ryegrass, *Lolium multiflorum* Lam.; black nightshade, *Solanum nigrum* L.; crowfootgrass, *Dactyloctenium aegyptium* (L.) Willd; goosegrass, *Eleusine indica* (L.) Gaertn.; green foxtail, *Setaria viridis* (L.) Beauv; Johnsongrass, *Sorghum halepense* (L.) Pers.; redroot pigweed, *Amaranthus retroflexus* L.; sicklepod, *Senna obtusifolia* (L.) H. S. Irwin & Barneby; stranglervine, *Morrenia odorata* (Hook. & Arn.) Lindl.; velvetleaf, *Abutilon theophrasti* Medik; wild mustard, *Brassica kaber* (DC.) L. S. Wheeler; yellow nutsedge, *Cyperus esculentus* L; clove, *Syzygium aromaticum* (L.) Merr. & L. M. Perry; corn, *Zea mays* L.; garlic, *Allium sativum* L.

Key words: Acetic acid, Alldown, broadleaf weeds, citric acid, clove oil, corn gluten meal (CGM), Groundforce, Matran II, narrowleaf weeds, soil type, vinegar, young weeds.

There is increasing public concern about food quality and safety. Organic production is increasing, and there is very little research support for this expanding production system (Derksen et al. 2002). For example, certified organic crops in the United States were grown on 161,000 ha in 1992, but increased to 565,600 ha by 2003 (USDA 2005). Poor weed control is often cited as a major reason for lower yields in organic production (Gianessi and Reigner 2007; Peacock and Norton 1990). Organic crop growers cited weed control as their greatest difficulty in crop production (Stopes and Millington 1991; Walz 1999) because they are not permitted to use synthetic herbicides. Hand-weeding and cultivation are substitutes for herbicides at a greatly increased cost and with reduced effectiveness (Boyd et al. 2006; Gianessi and Reigner 2007). Organic farmers may have to spend up to $2,500/ha to adequately control weeds (Earthbound Organic 2006; Gianessi and Reigner 2007). Recently, some natural herbicides have been produced to control weeds, and the ingredients have been reviewed and approved by the Organic Materials Review Institute for their use in certified organic production (Chase et al. 2004; Ferguson 2004; Young 2004). However, few organically compliant herbicides exist, and even fewer have been tested adequately (Boyd and Brennan 2006; Curran et al. 2005).

Results of previous research indicated that corn gluten meal (CGM), citric acid (5%) + garlic (0.2%; Alldown), clove oil (45.6%; Matran II), citric acid (10%) + garlic (0.2%; Groundforce), acetic acid (vinegar), and citric acid proved effective as nonsynthetic herbicides for controlling weeds (Curran 2004; Law et al. 2006; Moran 2007; Preston 2003; Quarles 1999; Smith 2006; Zdor et al. 2005). CGM has been used successfully on lawns and high-value crops as a PRE herbicide (Bingaman and Christians 1995; Nonnecke and Christians 1993; Webber and Shrefler 2006). It must be applied just before weed seed germination to be effective and, at 1.61 t/ha, suppressed many common grasses and herba-

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Table 1. Summary of active ingredients, product concentrations, and sources used in experimental treatments.

Herbicide (active ingredients)	Product name	Concentration used in spray solution	Rate[a]	Product source or manufacturer
			L/ha	
Acetic acid (5%)	Household vinegar	Undiluted	188	Heinz North America, Pittsburgh, PA; www.heinz.com
Acetic acid (50%)	Acetic acid (60%)	30%	18.7	Ricca Chemical Company, Arlington, TX; www.riccachemical.com
Citric acid (10%)	Citric acid	Undiluted	188	Ricca Chemical Company, Arlington, TX; www.riccachemical.com
Citric acid (5%) + garlic (0.2%)	Alldown	Undiluted	188	Summerset Products, Inc. Bloomington, MN; www.sumrset.com
Citric acid (10%) + garlic (0.2%)	Groundforce	10%	18.8	Abby Laboratories, Inc., Ramsey, MN; www.abbylabs.com
Clove oil (45.6%)	Matran II	20%	37.5	EcoSMART Technologies, Franklin, TN; www.ecosmart.com
Corn gluten meal (CGM)	Corn gluten meal (CGM)	400 g/m^2	4 t	Bioweed, Environmental Factor, Oshawa, ON, Canada; www.environmentalfactor.com

[a] Rate from the commercial product.

ceous weeds (Preston 2003). In addition, Gough and Carlstrom (1999) reported that wheat (*Triticum aestivum* L.) gluten meal inhibited growth in a number of weed species. Acetic acid is an ingredient in several new herbicides on the market today. Researchers in Maryland tested 5% and 10% acetic acid for effectiveness in weed control (Anonymous 2002) and found that older plants required a higher concentration of acetic acid to kill them. At the higher concentration, control was 85 to 100%; however, the solution at lower concentration (5%) burned off the top growth with 100% success. Citric acid (5%) + garlic (0.2%) and 20% of Matran II (clove oil, 45.6%) provided more than 70% weed control within the first week, but control decreased to less than 60% by 3 wk after treatment (WAT; Chase et al. 2004). Natural herbicides can be applied either as formulation without carrier or mixed with different volumes of carriers in the spray solution. In this respect, burning nettle (*Urtica urens* L.) dry weight was reduced by 90% with 12 to 61 L clove oil/ha, whereas 21 to 38 L clove oil/ha was required to reduce common purslane (*Portulaca oleracea* L.) biomass to the same level (Boyd and Brennan 2006). The herbicide efficacy varied according to the growth stage of weeds and the herbicide concentration in spray solution (Boyd et al. 2006; Smith 2004, 2006). Curran (2004) showed 99% control of redroot pigweed (*Amaranthus* spp.) and velvetleaf (*Abutilon theophrasti* Medicus) with 23 to 47% clove oil mixture in a spray volume of 281 L/ha or 12 to 23% clove oil mixture in a spray volume of 562 L/ha when weeds were less than 7.6 cm tall. Clove oil effectively controlled broadleaf weeds when applied at high concentrations but did not effectively control some grass species (Boyd and Brennan 2006). Smith (2004) reported that 76 to 93% and 97 to 99.5% weed control was achieved with 10% and 20% clove oil, respectively, in a spray volume of 337 L/ha. Smith (2004) also noted that the best weed control occurred on small weeds with 1 to 2 leaves. The present study was undertaken to evaluate the efficacy of some nonsynthetic herbicides on six broadleaf weeds and six narrowleaf weeds at two weed growth stages and to examine the performance of corn gluten meal as an herbicide in two soil types.

Materials and Methods

Greenhouse experiments were conducted at the Citrus Research and Education Center (CREC), Lake Alfred, FL, to examine weed control efficacy of some nonsynthetic herbicides on six broadleaf weeds as well as six narrowleaf weeds. Natural herbicide treatments were applied to the broadleaf weeds stranglervine, wild mustard, black nightshade, sicklepod, velvetleaf, and redroot, and to the narrowleaf weeds crowfootgrass, Johnsongrass, annual ryegrass, goosegrass, green foxtail, and yellow nutsedge.

A summary of the natural product herbicides and their active ingredients used in this study are presented in Table 1. Some tested herbicides, such as acetic acid (5%; household vinegar), citric acid (10%), citric acid (5%) + garlic (0.2%), and CGM are ready-to-use in concentration without dilution or added to a carrier. Therefore, we used these herbicides without dilution, at a rate of 188 L/ha plus 2 L/ha organic oil. Matran II (clove oil [45.6%]), acetic acid (50%), and Groundforce (citric acid [10%] + garlic [0.2%]) required dilution.

Seeds were sown in plastic trays containing commercial potting medium.[1] Plants were grown in the greenhouse under natural daylight at 25/16 C day/night temperatures and at 70% ± 5% relative humidity. The plants were watered and fertilized with foliar fertilizer[2] containing 20–20–20 (N–P_2O_5–K_2O) to promote optimum growth. The broadleaf plants reached heights of 3 to 5 cm and 6 to 10 cm and grasses were 4 to 7 cm and 8 to 12 cm at the time of spray application for early POST (EPOST) and late POST (LPOST) treatments, respectively. Crop oil was added at 1% (v/v) for all herbicides, except CGM. Plants were sprayed using a chamber track sprayer[3] fitted with a TeeJet 8002 flat-fan spray nozzle,[4] delivering a 190 L/ha at 140 kPa pressure. Each experimental unit was a tray, replicated four times and arranged in a completely randomized-block design. For CGM, the experiments were conducted using two different soils: commercial potting medium and soil from citrus groves at CREC. Citrus grove soil was collected from 0 to 10 cm depth between rows using a stainless steel probe along transects established from a field that had not been treated with herbicides. Soil composition was 97% sand, 1% silt, and 2% clay (with a pH of 7.0 and 1.3% organic matterr).

Visual observations on mortality were recorded at weekly intervals to 5 wk after treatment (WAT). General observation on the efficacy of each herbicide on all weeds at EPOST and LPOST stage was taken at 5 WAT. Visual evaluations were recorded using a 0 to 100 scale, where 0 meant no visible effects and 100 meant complete control. Data expressed as

Table 2. Efficacy of nonsynthetic herbicides applied at two growth stages on six broadleaf weeds at 1 to 4 WAT.[a,b]

		Stranglervine		Wild mustard		Black nightshade		Sicklepod		Velvetleaf		Redroot pigweed	
Treatments		1 WAT	4 WAT	1 WAT	4 WAT	1 WAT	4 WAT	1 WAT	4 WAT	1 WAT	4 WAT	1 WAT	4 WAT
		Efficacy %											
AA (5%)	EPOST	95 b	93 b	63 f	38 e	95 b	98 a	65 d	52 e	95 a	100 a	0 g	0 f
	LPOST	9 h	8 f	17 g	17 f	27 g	18 i	0 i	0 h	38 d	47 d	0 g	0 f
AA (30%)	EPOST	97 ab	99 a	100 a	100 a	100 a	100 a	70 c	62 d	97 a	100 a	93 b	100 a
	LPOST	22 f	20 e	95 a	100 a	68 d	57 d	67 d	20 g	83 c	77 c	75 d	52 d
CA (10%)	EPOST	98 a	98 a	82 d	62 d	85 c	98 a	75 b	72 c	95 a	95 a	50 e	50 d
	LPOST	23 f	0 g	88 c	95 b	30 f	35 g	50 e	18 g	15 g	25 e	0 g	0 f
CA (5%) + G	EPOST	100 a	100 a	100 a	100 a	98 a	100 a	95 a	92 b	90 b	98 a	100 a	100 a
	LPOST	24 f	20 e	95 b	98 a	34 e	45 f	44 f	0 h	21 f	15 f	17 f	18 e
CA (10%) + G	EPOST	75 d	55 d	70 e	60 d	30 f	22 h	25 h	17 g	25 e	0 g	0 g	0 f
	LPOST	10 h	0 g	98 a	100 a	25 g	45 f	0 i	0 h	0 h	0 g	0 g	18 e
Clove oil	EPOST	15 g	0 g	18 g	18 f	0 h	0 j	27 h	27 f	0 h	0 g	0 g	0f
(45.6%)	LPOST	5 i	0 g	80 d	100 a	27 g	50 e	0 i	0 h	0 h	0 g	0 g	0 f
CGM	CPM	80 c	55 d	99 a	95 b	95 b	92 b	73 b	97 a	98 a	83 b	100 a	72 c
	SS	55 e	72 c	88 c	72 c	83 c	87 c	33 g	95 a	97 a	99 a	83 c	93 b

[a] Abbreviations: WAT, weeks after treatment; EPOST, early POST; LPOST, late POST; AA, acetic acid; CA, citric acid; G, garlic (0.2%); CGM, corn gluten meal; CPM, commercial potting medium; SS, sandy soil.

[b] Values within a column followed by a different letter are significantly different at $P = 0.05$.

percentages were arc-transformed before analysis and converted back to percentages for presentation purposes. The experiment was repeated twice under similar conditions, and pooled data were analyzed using Agriculture Research Management[5] software. Means were separated with Fisher's Protected LSD test at P = 0.05.

Results and Discussion

Weed Control Efficacy. Visual observation data were expressed as a percentage of the control treatment and were recorded at 1 to 4 WAT for individual broadleaf weed species (Table 2) and narrowleaf weeds (Table 3). The data were recorded up to 5 WAT; however, there were insignificant differences among observations recorded at 4 and 5 WAT, and, therefore, the data recorded at 5 WAT were excluded. Overall herbicide efficacy at both growth stages on broadleaf weeds is presented in Figure 1 and on narrowleaf weeds in Figure 2.

Acetic Acid (5%; Household Vinegar). Acetic acid (5%) applied EPOST resulted in 93, 98, and 100% control of stranglervine, black nightshade, and velvetleaf, respectively, at 4 WAT (Table 2). In previous research, Radhakrishnan et al. (2002) reported that herbaceous weeds sprayed with various solutions of acetic acid and concentrations of less than 10% killed the weeds within 2 wks after emergence. Delay of application significantly reduced herbicide efficacy, especially with stranglervine (Table 2). Acetic acid (5%) did not control redroot pigweed (Table 2). Furthermore, acetic acid (5%) gave low efficacy on the narrowleaf weeds when applied at both EPOST and LPOST (Table 3). Our results are in accord

Table 3. Efficacy of nonsynthetic herbicides applied at two growth stages on six narrowleaf weeds at 1 to 4 WAT.[a,b]

		Crowfootgrass		Johnsongrass		Annual ryegrass		Goosegrass		Green foxtail		Yellow nutsedge	
Treatments		1 WAT	4 WAT	1 WAT	4 WAT	1 WAT	4 WAT	1 WAT	4 WAT	1 WAT	4 WAT	1 WAT	4 WAT
		Efficacy %											
AA (5%)	EPOST	0 g	0 c	0 g	0 d	52 b	27 d	0 g	0 e	40 d	28 e	38 d	3 c
	LPOST	0 g	0 c	8 f	0 d	13 e	8 e	0 g	0 e	12 f	12 f	0 f	0 c
AA (30%)	EPOST	35 c	25 b	95 a	95 a	93 a	100 a	97 a	100 a	98 a	100 a	75 c	58 a
	LPOST	20 d	0 c	40 c	0 d	35 d	22 d	98 a	93 b	48 c	50 c	11 e	0 c
CA (10%)	EPOST	13 e	0 c	0 g	0 d	0 f	0 f	0 g	0 e	0 g	0 g	0 f	0 c
	LPOST	0 g	0 c	23 e	0 d	0 f	0 f	23 e	15 d	0 g	0 g	0 f	0 c
CA (5%) + G	EPOST	0 g	0 c	12 f	0 d	43 c	0 f	42 c	0 e	0 g	0 g	0 f	0 c
	LPOST	5 f	0 c	30 d	0 d	10 e	0 f	33 d	0 e	0 g	0 g	0 f	0 c
CA (10%) + G	EPOST	0 g	0 c	20 e	2 d	0 f	0 f	0 g	0 e	0 g	0 g	0 f	0 c
	LPOST	0 g	0 c	10 f	0 d	0 f	0 f	11 f	32 c	0 g	0 g	0 f	0 c
Clove oil (45.6%)	EPOST	0 g	0 c	0 g	0 d	0 f	0 f	0 g	0 e	0 g	0 g	0 f	0 c
	LPOST	10 e	0 c	12 f	0 d	0 f	0 f	11 f	30 c	0 g	0 g	0 f	0 c
CGM	CPM	100 a	97 a	55 b	77 b	90 a	95 b	98 a	97 a	32 e	42 d	83 b	50 b
	SS	90 b	98 a	42 c	32 c	50 b	40 c	47 b	18 d	55 b	65 b	92 a	48 b

[a] Abbreviations: WAT, weeks after treatment; EPOST, early POST; LPOST, late POST; AA, acetic acid; CA, citric acid; G, garlic (0.2%); CGM, corn gluten meal; CPM, commercial potting medium; SS, sandy soil.

[b] Values within a column followed by a different letter are significantly different at $P = 0.05$.

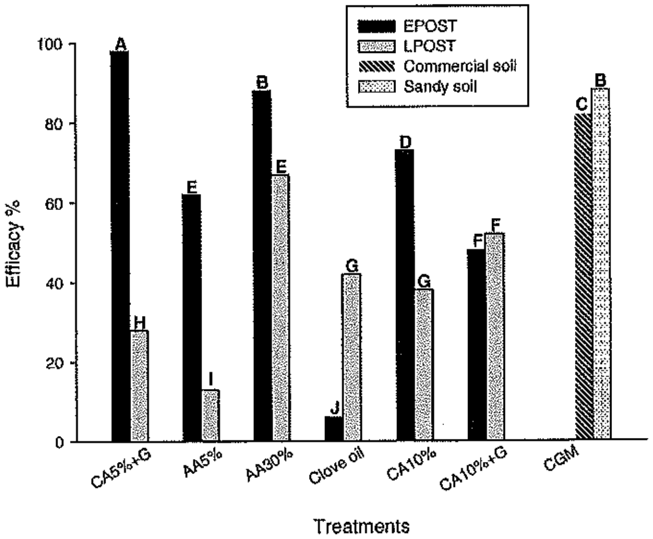

Figure 1. Visual assessments of broadleaf weed injury as affected by the nonsynthetic herbicides at 5 weeks after treatments. Abbreviations: EPOST, early POST; LPOST, late POST; CA, citric acid; AA, acetic acid; G, garlic (0.2%); CGM, corn gluten meal. Columns with the same letters are not statistically different at P = 0.05.

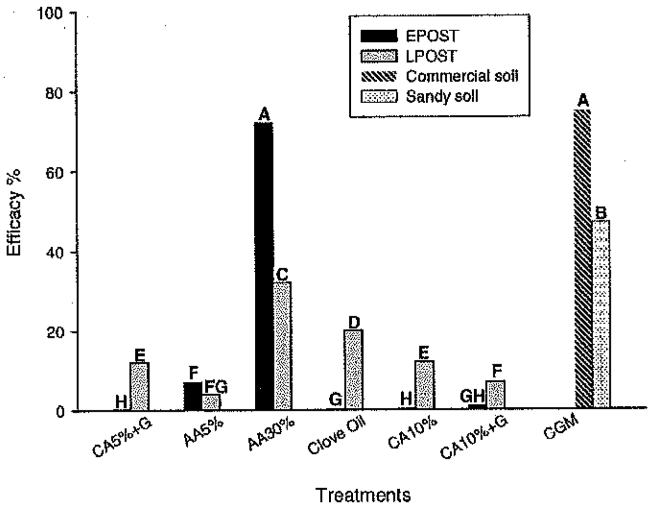

Figure 2. Visual assessments of narrowleaf weed injury as affected by the nonsynthetic herbicides at 5 weeks after treatments. Abbreviations: EPOST, early POST; LPOST, late POST; CA, citric acid; AA, acetic acid; G, garlic (0.2%); CGM, corn gluten meal. Columns with the same letters are not statistically different at P = 0.05.

with Young (2004), who reported that acetic acid (5%) did not adequately control the narrowleaf weeds.

Acetic Acid (30%). As shown in Tables 2 and 3, 30% acetic acid controlled all of the tested broadleaf weeds and most narrowleaf weeds, if applied at the early stage (two to four true leaves or earlier). Increasing the concentration of acetic acid from 5 to 30% in spray solution and applying EPOST provided excellent (95 to 100%) control of tested weeds, except for sicklepod, crowfootgrass, and yellow nutsedge, where the control was 62, 25, and 58%, respectively, at 4 WAT. Two hours after herbicide application, the leaves and shoots of sensitive weeds were killed (personal observation). Comis (2002) and Moran (2007) reported that 10 to 20% acetic acid concentration gave 80 to 100% weed control and was more effective than 5% acetic acid. Treating young weeds increased susceptibility of weed seedlings to acetic acid (30%). LPOST application caused complete growth inhibition (93 and 100%) of wild mustard and goosegrass but had no phototoxic effect on crowfootgrass and Johnsongrass (Tables 2 and 3). Acetic acid (30%) applications provided less than 75% yellow nutsedge control. In previous research, annual grasses were controlled at least 79% with a single application of acetic acid at 9% concentration (Young 2004), whereas Webber and Shrefler (2007) reported that acetic acid was less effective in controlling narrowleaf than broadleaf weeds. Acetic acid application at early weed stages inhibited the growth of all weeds except for crowfootgrass (Tables 2 and 3). These results suggest that among the weeds tested, crowfootgrass is most tolerant to acetic acid. Daniels and Fults (2002) reported from greenhouse and field studies that, although application of acetic acid (5%) solutions did not provide reliable weed control, solutions of 10, 15, and 20% provided 80 to 100% control of certain annual weeds (foxtail, lambsquarters, pigweed, and velvetleaf). In addition, the perennial weed Canada thistle [*Cirsium arvense* (L.) Scop.], treated with 5% acetic acid showed 100% shoot burn down, but roots were unaffected; therefore, shoots always regrew.

Citric Acid (10%). This herbicide was highly effective on stranglervine, black nightshade, and velvetleaf, with control 95% or higher at 4 WAT (Table 2). However, it showed lower activity (< 72% control) when applied to the other broadleaf weeds. Narrowleaf weeds were not substantially affected by citric acid sprayed on either young or taller narrowleaf weeds.

Citric Acid (5%) + Garlic (0.2%; Alldown). Application of this herbicide to younger broadleaf weeds provided 90 to 100% control within 1 WAT. At 4 WAT, the treatment provided similar control of weeds as recorded at 1 WAT (Table 2). Chase et al. (2004) reported that this mixture provided more than 70% weed control within the first week but decreased to less than 60% by 3 WAT. Delayed application of this combination on wild mustard resulted in 95% and 98% control at 1 and 4 WAT, respectively. However, the herbicide phytotoxicity on the other five broadleaf weeds when applied LPOST was significantly less effective (< 67%), and at 4 WAT, the phytotoxicity was reduced, and weeds began to recover from damage.

Crowfootgrass, green foxtail, and yellow nutsedge were not affected by any treatments applied EPOST or LPOST (Table 3). The reason for the reduced control in grasses with contact herbicides may be due to the shielding of the growing point by plant tissue (Boyd et al. 2006), whereas the growing point in broadleaf weeds is much more accessible to herbicides. Among all weeds used in this study at both EPOST and LPOST, wild mustard was more sensitive than other weeds to citric acid (5%) + garlic.

Citric Acid (10%) + Garlic (0.2%; Groundforce). This herbicide is similar to the previous herbicide discussed above, but the concentration of citric acid is higher. In most cases, increasing citric acid from 5 to 10% in this herbicide did not enhance herbicide phytotoxicity but had low efficiency compared with the herbicide containing citric acid (5%) + garlic (0.2%). Delayed application of citric acid (10%) plus garlic (0.2%) can effectively control wild mustard (100% control) but provided less than 60% control of stranglervine and wild mustard when applied EPOST (Table 2). Application of this herbicide either EPOST or LPOST had no effect upon velvetleaf, redroot pigweed, and all narrowleaf weeds except goosegrass, where control was 32% with the LPOST application (Tables 2 and 3). Poor control of black nightshade and sicklepod was recorded with this formulation (Table 2).

Results indicate that the citric acid (5%) + garlic (0.2%) has good potential for use as a natural herbicide. This herbicide caused 98% mortality of broadleaf weeds (Figure 1) and exhibited lower efficiency or no effect against narrowleaf weeds (Figure 2). The active ingredients of Alldown and Groundforce are citric acid and garlic but the difference between them is the concentration of citric acid, where its concentration in Alldown is half of that in Groundforce. Surprisingly, the efficacy of Alldown (citric acid [5%] + garlic [0.2%]) was better than that of Groundforce (citric acid [10%] and garlic [0.2%]) as shown in Figures 1 and 2. Johnson (2005) reported that citric acid (10%) plus garlic did not effectively control any of the weeds present in his trials. However, others have reported satisfactory weed control with clove oil and citric acid (10%) + garlic (Boyd et al. 2006; Smith 2006; Tworkoski 2002).

Clove Oil (45.6%; Matran II). Clove oil provided poor control (0 to 35%) of all weeds except wild mustard and black nightshade, where complete (100%) and 50% control was achieved with this treatment at 4 WAT, respectively (Table 2). Ferguson (2004) reported that weed control with Matran II at recommended and higher concentrations was inconsistent, ranging from 10 to 40%, compared with 100% control with glyphosate. However, Smith (2006) showed that Matran II at 12.5 gallons/ha applied in more dilute solution (5.4%) provided excellent weed control. Chase et al. (2004) reported that 20% concentration of Matran II, provided better than 70% weed control within the first week, which decreased to less than 60% by 3 WAT.

The herbicidal activity of clove oil may be due to a significant loss of foliar membrane integrity (Bainard et al. 2006). According to Bainard et al. (2006), the presence of leaf epicuticular wax in weeds tolerant to clove oil may possibly protect their leaves from herbicide damage. Boyd et al. (2006) reported that clove oil controlled 95 to 97% of all tested broadleaf weeds.

Corn Gluten Meal. CGM reduced germination and seedling survival of all weeds (Tables 2 and 3). These results support previously reported data that a high rate of CGM (4 t/ha) maintained 72% total weed control and 83% broadleaf weed control until 46 d after planting (Webber and Shrefler 2006; Zdor et al. 2005). Sicklepod germinated in the sandy soil treated with CGM, but at 4 WAT, 97% of seedlings were dead (Table 2). In general, CGM caused 70 to 90% weed control, the lowest for stranglervine and the highest for velvetleaf and crowfootgrass (Tables 2 and 3). Kuk et al. (2001) reported that CGM caused 32, 94, and 64% reduction in plant stands of velvetleaf, sicklepod, and goosegrass, respectively, compared with control.

Data in Tables 2 and 3 and Figures 1 and 2 indicate that CGM was less effective in controlling narrowleaf weeds than broadleaf weeds, particularly in sandy soil. However, application of CGM provided complete control (95 to 97%) of crowfootgrass, annual ryegrass, and goosegrass; substantial inhibition (83%) of green foxtail; and moderate control (less than 77%) of Johnsongrass and yellow nutsedge. Application of CGM in sandy soil resulted in 90 and 98% control of crowfootgrass and yellow nutsedge at 1 WAT, whereas the phytotoxicity was reduced on yellow nutsedge at 4 WAT (Table 3). Similar findings were reported by Bingaman and Christians (1995), Chase et al. (2004) and Zdor et al. (2005).

The efficacy of CGM was significantly affected by the soil type, where the percentage of control of wild mustard, velvetleaf, pigweed, annual ryegrass, and goosegrass at 4 WAT were 95, 83, 72, 95, and 97% in commercial potting medium, compared with 72, 99, 93, 40, and 18% for the same weeds germinated in sandy soil, respectively (Tables 2 and 3). The results in Figures 1 and 2 indicated that the control of broadleaf and narrowleaf weeds at 5 WAT were 82 and 75% in commercial potting medium, compared with 88 and 47% for the same weeds germinated in sandy soil, respectively.

It has been previously reported by Liu and Christians (1997) that CGM applied PRE inhibits seed germination and seedling growth for more than 4 WAT. Bingaman and Christians (1995) reported that application rates of CGM at 3.2, 6.4, and 9.6 t/ha reduced black nightshade survival by 82, 88, and 99%, respectively.

CGM inhibits root growth of germinating seeds but does not damage plants that have formed a mature root system, and this inhibition may be attributed to the presence of root-inhibiting dipeptides in CGM (Liu and Christians 1997). It could be concluded that CGM can be used as PPI herbicide for organic crop production (Webber and Shrefler, 2006). However, McDade and Christians (2000) advised against using incorporated CGM for direct-seeded vegetables.

The results in Tables 1 and 2 indicate that the tested herbicides provided better weed control with early application than late application, and the potential for this response varies among weeds and herbicides (Tables 2 and 3). These results coincide with those reported by Chase et al. (2004) and Ferguson (2004). Delaying the application allowed growth of weeds to increase twofold or threefold. Thickness, chemical composition, and ultrastructure of the epicuticular wax differ among plant species and with the age of the plants (Holloway 1970). These results also give anecdotal support to the concept that the morphological and physicochemical characteristics of leaves of various weed species influence the behavior of herbicides on the leaf surface and may lead to differential activity of a given herbicide from one weed species to another (Sanyal et al. 2006; Young 2004). None of the herbicides provided satisfactory control of narrowleaf weeds, except for acetic acid 30%, EPOST, and CGM. The difference between broadleaf and narrowleaf weeds partially occurs because all tested herbicides, except CGM, are contact herbicides, and the growing point for broadleaf weeds is above the ground, whereas the growing point for grasses remains below ground in the early growth stages (Boyd et al. 2006).

Wild mustard and black nightshade were more sensitive to the herbicides tested, whereas redroot pigweed was difficult to control with clove oil, acetic acid (5%), and citric acid (10%) + garlic (0.2%) treatments. The differences in leaf-surface morphology between these species could be responsible for this mortality difference (Sanyal et al. 2006).

Overall, results presented in Figure 1 indicate that citric acid (5%) + garlic (0.2%), citric acid (10%), and CGM were efficacious against broadleaf weeds tested in this study, when compared with untreated weeds. Acetic acid (30%) was more effective on all tested broadleaf weeds and most narrowleaf weeds if applied at an early stage (two to four true leaves or before). It provided 88 and 72% control of broadleaf and narrowleaf weeds, respectively (Figures 1 and 2). This treatment could be used to control weeds in the stale-seedbed technique for organic vegetable production.

We conclude that citric acid (5%) + garlic (0.2%) and acetic acid (30%) could be applied before planting to control weeds, as a stale-seedbed technique, in directed sprays between crop plants, between orchard trees, and in wide-row plantations. In addition, citric acid + garlic may also be applied POST in some crop species (Smith 2004; Evans and Bellinder 2009). CGM is effective as a PPI herbicide and could be combined with citric acid (5%) + garlic (2%) or acetic acid (30%) to improve weed management in organic cropping systems.

Sources of Materials

[1] Commercial potting medium. Metro-Mix500, Grace-Sierra Horticultural Products Company (now Scotts Company), 14111 Scottslawn Road, Marysville, OH 43041.

[2] Tracite foliar fertilizer. Helena Chemical Co., 7664 Moore Road, Memphis, TN 38120.

[3] Allen track sprayer. Allen Machine Works, 607 E. Miller Road, Midland, MI 48640.

[4] Teejet 8003 flat-fan nozzles, Spraying Systems Co., North Ave., Wheaton, IL, 60788.

[5] Pesticide Research Manager Software. Gylling Data Management Inc., 405 Martin Boulevard, Brookings, SD 57006.

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