Dow AgroSciences LLC
9330 Zionsville Road
Indianapolis, IN 46268-1054

308/2E
Nov 1, 2005

RECEIVED
USDA NATIONAL
ORGANIC PROGRAM

2005 NOV -2 A 10: 17

Dow AgroSciences

National Organic Standards Board
c/o Mark Bradley, Associate Deputy Administrator
USDA/AMS/TMP/NOP, Room 4008-So.
1400 Independence Avenue, SW
Washington, DC 20250-0020

PETITION FOR THE LISTING OF PELARGONIC ACID AND RELATED C6-C12 FATTY ACIDS ON THE USDA NATIONAL LIST OF ALLOWED AND PROHIBITED SUBSTANCES

The Organic Foods Production Act of 1990, as amended, established a National List of Allowed and Prohibited Substances (National List) which identifies the synthetic substances that may be used, and the nonsynthetic substances that cannot be used, in organic production and handling operations. The act also provides a mechanism to petition the National /Organic Standards Board to evaluate a substance for inclusion on or removal from the National List. With this petition, Dow AgroSciences requests review of a naturally occurring fatty acid ~ Pelargonic Acid and Related C6-C12 Fatty Acids for consideration as, if appropriate, listing on the Proposed National List of Organic Substances for inclusion on:

1. The list of allowed substances for use in organic crop production.

Pelargonic Acid and Related C6-C12 Fatty Acids is a naturally occurring fatty acid which can be found at appreciable concentrations in a variety of plant and animal food and non-food products. Listing of pelargonic acid on the national list will facilitate new weed management options for organic agriculture and support subsequent assessments of end-use formulations by appropriate state organizations. Only end-use formulations that contain previously certified organic components or EPA list-4 inert components would be submitted to state certification organizations.

Pelargonic Acid and Related C6-C12 Fatty Acids is an EPA registered active ingredient. As such extensive risk assessments and safety standards have been met, such as toxicological and metabolism studies, ecological toxicological studies, and environmental fate assessments. Thus Pelargonic acid has been fully evaluated for use as an herbicide on multiple crops. This natural product has been found by EPA to have large margins of safety to workers, non-target organisms and the environment, attributes that are important for the organic grower.

We appreciate the time and effort that the Department of Agriculture, Agricultural Marketing Services, invests in the review of petitions for organic status. Please feel free to contact me at my phone number or e-mail address below if you have any questions on any aspect of this petition.

Sincerely,

Robert Sibley

Robert Sibley
Regulatory Specialist
Dow AgroSciences LLC
Phone: 317-337-5463
Fax: 317-337-4649
E-mail: rbsibley@dow.com

Petition for the Inclusion of Pelargonic Acid and Related C6-C12 Fatty Acids on the National Organic Standards Board List of Approved Organic Substances.

With this petition, Dow AgroSciences LLC is requesting the evaluation of Pelargonic Acid and Related C6-C12 Fatty Acids for inclusion on:

1. The list of allowed substances for use in organic crop production.

The following information addresses the Department of Agriculture, Agricultural Marketing Services Notice of Guidelines and Call for National List Petitions as discussed in the July 13, 2000 Federal Register Notification (Volume 65, 43259 – 43261).

Pelargonic Acid and Related C6-C12 Fatty Acids for Weed Management

1. The common name for the substance:

Pelargonic Acid and Related C6-C12 Fatty Acids is a common fatty acid naturally present in many plants. Pelargonic Acid was first found in several essential oils including those of rose, geranium, hops and French lavender.

Taking its common name from the geranium family, *pelargonium* the 9 carbon molecule is also known by its IUPAC name of nonanoic acid. Pelargonic Acid and Related C6-C12 Fatty Acids is the active ingredient in Scythe® herbicide.

ISO common name	Pelargonic Acid CAS # 112-05-0
Chemical name IUPAC name	nonanoic acid

Chemical Abstract name:
Chemical Structure: $CH_3(CH_2)_7COOH$

Synonyms	Scythe, Herbicidal acid

2. The manufacturer's name, address and telephone number.

Dow AgroSciences LLC
9330 Zionsville Road
Indianapolis, IN 46268

Contact: Robert Sibley
Phone: (317) 337-5463
Fax: (317) 337-4649
E-mail rbsibley@dow.com

3. The intended or current use of the substance:

<u>It is the intent of this petition to register for use in organic food and feed production as an herbicide.</u>

Pelargonic Acid and Related C6-C12 Fatty Acids is currently registered with the EPA for use as an herbicide (EPA reg# 62719-529). It is a carboxylic acid that is naturally derived from oleic acid that originates from a number of natural fats and oils including animal and plant oils and fats.

Pelargonic acid has been in public use since the 1930's mainly in industrial uses like flavors and perfumes, lubricants, plasticizers, and coatings,. Pelargonic acid is also used in processing fruits and vegetables and as a flavoring and sterilizing agent. Additionally, the product is used in solution as a peeling solution for fresh fruits and vegetables (21 CFR part 173.315).

Pelargonic acid has also been registered as a blossom thinner (EPA # 53219-11) however, the registration is not current for this use.

4. A list of the crop, livestock or handling activities for which the substance will be used. If used for crops or livestock, the substance's rate and method of application must be described. If used for handling (including processing), the substance's mode-of-action must be described.

Pelargonic acid, the active ingredient in Scythe herbicide is a contact, non-selective, broad spectrum, foliar-applied herbicide product that can be used to control weeds before planting and prior to harvesting, to burn-down weeds, to facilitate harvest, as a harvest aid or desiccant to root and tuber vegetables, on bulb vegetables or cotton, and it has previously been used for blossom thinning in fruit trees like apples and pears. Pelargonic acid is currently approved for use on root, tuber and perennial vegetables that include, bulb vegetables, leafy vegetables, cole or Brassica crops, legume vegetables, fruiting vegetables, cucurbits and melons, citrus, pome fruits, stone fruits, small fruits, berries, grapes, nuts, tropical fruits, field crops and cereal grains, forages and pasture grasses, herbs and spices, cocoa, coffee, hops, and tea. Other uses include tobacco, jojoba, turf, flowers, bedding and landscape plants, trees and shrubs, greenhouse and indoor use, non-crop, industrial, and public areas such as schools, golf courses, and campgrounds, structures, buildings, and walkways, dry aquatic sites, dry drainage systems and around aquatic sites.

This request is for Pelargonic Acid Technical, the isolated active principal derived from oleic acid. It is understood that only end-use formulations that contain certified organic components or EPA list-4 inert components will be considered for organic crop production.

Pelargonic acid based products were first registered in February 1997 as a stand alone herbicide. In the short time it has been on the market as Scythe Pelargonic acid's quick burn-down with no residual effect has created many specialty applications from nursery weed control, to blossom thinning in apples and pears, to marking lines on grass tennis courts.

As an herbicide the product is applied at rates between 3 to 10% solution and delivered in 75 to 200 gallons per acre through boom, hand-held or high volume equipment.

For control of annual weeds, mosses and cryptograms use a 3 to 5% solution. Use the lower rate in the rate for young, succulent and actively growing weeds and the higher rate for weeds greater than six inches height or in the flowering stage. Use higher rate for control of mosses, lichens and other cryptograms on structures and surfaces.

For burn-down of perennial herbaceous plants, weeds in a later stage of growth and control of sucker growth use a 5 to 7% solution. Use the highest rate for perennial weeds at or beyond the flowering stage or when the plants have "hardened".

For maximum vegetative burn-down, edging or foliar trimming use a 7-10% solution.

As a blossom thinner the product was applied at a rate of 2-2.5 pints per 100 gallons of spray solution in an airblast spray system using 200-400 gallons per acre. Rates went as low as 0.5 pint to as high as 4 pints if previous experience indicated that they were safe and effective at a particular site or on a particular variety.

Pelargonic Acid as an active ingredient in herbicides is exempt from tolerances under 40CFR Section 180.1159 established in May 1997 by the U.S. EPA on most crop plants and crop plant groups, including a wide range of minor and specialty crops under 40 CFR 180.1159(b) provided that:

- Applications are not made directly to the food commodity except when used as a harvest aid or desiccant to: any root and tuber vegetable, bulb vegetable or cotton.
- When Pelargonic acid is used as a harvest aid or desiccant, applications must be made no later than 24 hours prior to harvest.

Additionally, tolerances exist for blossom thinning under 40 CFR 180.1159(a).

Pelargonic acid is cleared by the FDA as a flavoring agent in food for human consumption (21CFR 172.515), as an adjuvant, production aid and sanitizer to be used in contact with food (21 CFR 178.1010 (b)), and in washing or to assist in lye peeling of fresh fruits and vegetables (up to 1%) (21 CFR 173.315).

5. The source of the substance and a detailed description of its manufacturing or processing procedures from the basic component(s) to the final product.

<u>Pelargonic Acid (Agnique FAC 9) Manufacturing Process</u>:

Figure 1. Pelargonic Acid Technical Manufacturing Process (Appendix A)

Pelargonic acid is produced by ozonolysis of oleic acid into two molecules, azelaic acid (C9 dicarboxylic acid) and Pelargonic acid (C9 carboxylic acid). The Pelargonic acid is separated from the azelaic acid by distillation and then purified by fractional distillation. The technical profile of this product is shown in table 2. The oleic acid is produced by high pressure/high temperature hydrolysis of natural fats and oils that originate from a number of sources including animal and plant oils and fats. Ozone is produced by an electrical discharge in air or oxygen. The processes used in this Ozone molecular separation generate very little waste as the different streams (Pelargonic and Azelaic acids) are recovered and used in a number of applications.

The key elements for considering Pelargonic acid as organic are:

- Produced from natural fats and oils, i.e., not petroleum based.
- The natural product, ozone is used as the oxidizing agent, ozone is produced by an electrical discharge in air.
- Waste streams are incorporated into other products.

Figure 2. Technical Data Sheet for Pelargonic Acid (Agnique FAC 9) from Cognis Corporation.

Composition

C9 Pelargonic Acid

Technical Data

Item	Value	Method
Appearance	Clear liquid at 15°C	
Water Content	Max. 0.2%	AOCS Tb 2-64
Flash Point	140°C	ASTM D 92
Boiling Range:	230-237°C (760 mm Hg)	ASTM D 1078
Acid Value	345-355	AOCS Te 2a-64
Ash Content	Ca. 25 ppm	ASTM D 482
Color (Trans 440/550 nm)	90-100/90-100	AOCS Cc 13a-50
Titer	8-11 °C	Cognis 622.01
Pelargonic acid	90-100%	Q-C 3407.0

Additional Technical Data

Item	Value	Method
C6 (acid)	<1%	Cognis 622.01
C7 (acid)	1%	Cognis 622.01
C8 (acid)	4%	Cognis 622.01

C9 (acid)	93%	Cognis 622.01
Other acids	2%	Cognis 622.01

Because the active substance is derived from natural sources, Pelargonic acid contains several related C6-C12 fatty acids, which cannot easily be separated totally from the main substance Pelargonic acid. The purity of the active substance can be expressed as shown in the table above (figure 2).

6. A summary of any available previous reviews by state or private certification programs or other organizations of the petitioned substance.

History of Organic Pelargonic Acid Actions

Agency/Date	Review	Action
NOSB September 18-20, 1996	Introduction and initial review of Pelargonic acid technical	Despite support for Pelargonic acid, the NOSB felt it was premature to vote on its acceptance since it was their first introduction to the material and decided to table the decision until each board member received the appropriate background information. No further request or follow up was made by the registrant, Mycogen Corp.. In 1998 Mycogen Corp. was wholly purchased by Dow AgroSciences LLC. As a result of the purchase follow up on the development of a number of products like Scythe has been delayed.

7. Information regarding EPA, FDA, and State regulatory authority registrations, including registration numbers.

This petition requests the listing of Pelargonic Acid and Related Fatty acids (C6-C12) on the USDA National List of Allowed or Prohibited Substances.

Pelargonic Acid is registered as an active ingredient in a number of end-use products; those products and EPA Registration Numbers are listed in the table below. Organic certification for those formulations containing only organic components and EPA list 4 inerts will be requested through certifying agencies such as OMRI. Development of specific organic formulations will be facilitated by the listing of Pelargonic Acid Technical.

Name	EPA Registration Number
Scythe Herbicide	62719-529
Sharpshooter (cancelled)	53219-5
Thinex (cancelled)	53219-11
Scythe L Herbicide	62719-342
AT Weed & Grass Killer Concentrate (transferred)	70108-1
AT Weed & Grass Killer Concentrate	40849-70
AT Weed & Grass Killer RTU (transferred)	70108-2
AT Weed & Grass Killer RTU	40849-71
Econosan Acid Sanitizer	4959-41
Mandate Plus	1677-194
West Agro Acid Sanitizer	4959-42

8. The Chemical Abstract Service (CAS) number.

Pelargonic Acid CAS No. 112-05-0

9. The substance's physical properties and chemical mode-of-action including

Pelargonic acid's herbicidal activity is by direct contact. It is absorbed only into green tissue through the cuticle and does not move systemically in the plant or penetrate woody tissue.

Pelargonic acid causes the dissolution of plant cell membranes and results in rapid cell death of green plant tissue. Bleaching of chloroplast and general ion leakage are apparent within minutes of application. It appears that the primary effect of Pelargonic acid is to cause a sudden drop in intra-cellular pH. This leads to declining cellular function, degradation of membranes, desiccation, and ultimately cell death (1).

- Pelargonic acid exerts its action as the parent herbicide without metabolic activation or degradation.
- Pelargonic acid is degraded in the environment by microbial means causing it to quickly loose its herbicidal activity.
- Pelargonic acid has no soil activity and is rapidly degraded in soil (t_{95} = 2 day)

(a) Chemical interactions with other substances, especially substances used in organic production;

Pelargonic acid-based products may be tank-mixed with other herbicidal and adjuvant products and fertilizers. See Scythe label in (Appendix B)

(b) Toxicity and environmental persistence:

Pelargonic Acid and Related C6-C12 Fatty Acids have been shown to be practically non-toxic have very low toxicity to birds, fish, aquatic invertebrates and bees. Pelargonic acid is rapidly degraded by microbes in all environmental matrices (t_{95} = 2 day); this characteristic makes it an excellent fit as an active ingredient in and around sensitive sites.

<u>Wildlife Toxicity Testing Summary for Pelargonic Acid</u>

Avian Dietary LC_{50} (Mallard Duck):	> 5620 ppm (Highest Dose Tested)
Avian Dietary LC_{50} (Bobwhite Quail):	> 5620 ppm (Highest Dose Tested)
Aquatic Toxicity LC_{50} (Bluegill):	>105 mg ai/L (Highest Dose Tested)
Aquatic Toxicity LC_{50} (Trout):	>91 mg ai/L
Aquatic Toxicity EC_{50} (Daphnia):	>96 mg ai/L
Acute Contact Toxicity LD_{50} (Honey Bees):	>25 µg ai/bee (Highest Dose Tested)

Organic agriculture embraces methods that minimize impact on the ecological balance of natural systems. Environmental burden from weed control products are reduced when biologically active compounds break down rapidly after application and, thus, do not have an opportunity to accumulate in unintended environmental compartments such as groundwater or living organisms such as fish. Pelargonic acid fully meets this standard. It is sorbed by soil particles, degrades quickly($t_{95} = 2$ day), is minimally soluble in water and is therefore essentially immobile in the environment.

One of the most important attributes of Pelargonic acid is its rapid degradation through beta oxidation to acetyl-coA. Acetyl-coA is utilized in the citric acid cycle producing energy, carbon dioxide and water.

Studies also conclude that Pelargonic acid is found to occur naturally in low concentrations in peat soils (2). These studies also show that the degradation of Pelargonic acid applied to soil occurs very rapidly (within a period of 2 days) by microbial means, not through hydrolysis or photolysis (3,4). Degradation of Pelargonic acid occurs under aerobic conditions with beta-oxidation being the principal pathway of metabolism. In addition, it has been demonstrated that the fatty acids can bind to the soil preventing leaching into water (4). "Effects of leaching, adsorption and desorption by Pelargonic acid in a soil environment would be very minimal due to strong acid-soil particle interaction and acid binding to the upper portion of the soil. (5)."

(c) Environmental impacts from its use or manufacture;

Pelargonic acid production is not synthetic nor are its byproducts. Pelargonic acid originates from a number of animal and plant oils and fats namely, beef tallow, sunflower, safflower and canola oils. These oils when heated and placed under pressure render oleic and other fatty acids. Oleic acid is isolated and split into Pelargonic acid and azelaic acid through the use of ozone generated by discharging electricity in the presence of oxygen. Production through ozonation is a natural process. The Pelargonic acid technical manufacturing process is described in detail in section 5.

The by-product of the manufacture of Pelargonic acid is Azelaic acid. The by-product from the breakdown of Pelargonic acid following a spray application is carbon dioxide and water.

Azelaic acid, a by-product from the manufacture of Pelargonic acid, is a simple molecule (HOOC(CH2)7COOH, (CAS Number 123-99-9), also known as 1,9-Nonanedioic acid.) Azelaic acid is found in some whole grains and in trace amounts in human bodies. Although it is an acid, it is a weak acid - similar to vinegar. The primary use of Azelaic acid is in medicine as Azelex ® distributed by Allergan, which is a cream base containing azelaic acid as 20% of its weight. It works in part by stopping the growth of skin bacteria that can help cause acne. It is also being used to combat hair loss as a hair growth stimulant.

Pelargonic acid's low potential for environmental impact is discussed further in Section 9(b) under Toxicity and Environmental Persistence.

(d) Effects on human health;

Scythe herbicide has many attributes that are desirable in terms of human/mammalian safety. The following discussion covers the three routes of potential human exposure to Scythe: ingestion, inhalation, and dermal contact/absorption.

Ingestion

The metabolism of naturally occurring fatty acids, such as Pelargonic Acid and Related C6-C12 Fatty Acids, in human digestion systems is very well characterized in the scientific literature. Fatty acid molecules are subject to very well known metabolic pathways in both eukaryotes and prokaryotes, such as the β-oxidation of fats which reduces fatty acids of many chain lengths by the sequential removal of two-carbon units as acetyl-CoA (6). Fatty acids, including Pelargonic Acid and Related C6-C12 Fatty Acids, are digested in mammalian systems through these normal metabolic pathways. Free fatty acids are kept in relatively low concentration in the body fluids and are bound to serum albumin while being transported in the blood. Considerable amounts of free fatty acids are transported from adipose tissue for metabolism in brain, muscle, and kidney.

Pelargonic Acid and Related C6-C12 Fatty Acids, when they are absorbed from the gastrointestinal tract into the blood, would not be treated differently from the free fatty acids released from adipose tissue. A study by Odle et al. (7) concluded that the metabolism of medium and long chain fatty acids by isolated hepatocytes of piglets has shown that the cells oxidized pelargonate (C9:0) to carbon dioxide and acid soluble products faster than the even-chained fatty acids of octanoate (C8) and oleate (C18).

To support the product registration of Scythe Herbicide, Mycogen conducted acute oral toxicity studies on both the formulation and the technical active ingredient Pelargonic Acid and Related C6-C12 Fatty Acids. The Acute Oral toxicity study conducted on Scythe Herbicide resulted in a LD50 of > 5,000 mg/kg, placing the product into EPA Toxicity Category IV (lowest level of toxicity). The acute data conducted on Pelargonic acid also resulted in a LD50 of > 5,000 mg/kg (the highest concentration tested for active and end use product).

Pelargonic acid naturally occurs in grapes, cheese and milk at levels from 10 PPM to 400 PPM. Some literature references (8, 9, 10, 11) cite its natural occurrence in soybean (trace levels), oranges (130 PPM), beans (trace levels), tobacco (0.27 PPM) and potatoes (1.18 PPM).

Due to the natural occurrence of Pelargonic Acid and Related C6-C12 Fatty Acids in certain foods, and the low toxicity demonstrated in the acute studies, EPA reviewed this fatty acid as a natural product.

Inhalation

The Acute Inhalation toxicity values for Scythe Herbicide and Pelargonic Acid and Related C6-C12 Fatty Acids confirm that the product is minimally toxic to humans through inhalation exposure. The result for Pelargonic acid is >1.244 mg/L, placing the LC50 for active ingredient into Toxicity Category III. The result for Scythe (MYX 6121) is > 5.29 mg/L, placing the LC50 for the product into EPA Toxicity Category IV. .

Dermal Contact/Absorption

The Acute Dermal LD50 is > 2,000 mg/kg, (the highest concentration tested) placing Scythe in EPA Toxicity Category III (low toxicity). The dermal irritation study concluded that Scythe is moderately irritating to the skin, but any adverse effects are reversible. Scythe is categorized by EPA as Toxicity Category III for dermal irritation. Finally, Scythe is not a dermal sensitizer as demonstrated in the dermal sensitization study.

Dermal exposure from handling and applying Scythe Herbicide should be mitigated by wearing the required Personal Protective Equipment (PPE) listed on the product label. The PPE includes: long-sleeved shirt and long pants, chemical resistant-gloves such as barrier laminate, nitrile rubber, or neoprene rubber, shoes plus socks and protective eyewear. Contact of Scythe Herbicide to the skin through penetration of clothing will produce moderate irritation effects noticeable to the worker. Washing with soap and water should remedy the irritation effects.

The studies below show that Pelargonic acid is severely irritating in dermal and eye tests (as expected for an organic acid) it must be noted that Scythe is a product which is mild and safe for applicators and for consumers of treated crops. The results of toxicological testing with Pelargonic Acid and Related C6-C12 Fatty Acids and formulated Scythe are listed below:

1. Studies Conducted on Technical Chemical = Pelargonic Acid

Acute Toxicity

Acute Oral LD_{50} (Rat):	>5000 mg/kg (Highest Dose Tested)
Acute Dermal LD_{50} (Rat):	>2000 mg/kg (Highest Dose Tested)
Acute Inhalation LC_{50} (Rat):	>1.244 mg/L
Dermal Irritation (Rabbit):	Severely Irritating
Eye Irritation (Rabbit):	Severely Irritating
Skin Sensitization (Guinea Pig):	Not sensitizing

Subchronic Toxicity - Range Finding for a 90-Day Rat Oral Toxicity (Diet):
NOAEL = 1,834 mg/kg/day (20,000 ppm) tested for period of two weeks (highest dose tested).

Chronic Toxicity - Chronic Mouse Dermal Toxicity Study (Mice):
NOAEL = 50 mg dosed twice-weekly for 80 weeks. No signs of toxicity were observed in treated mice. No evidence of severe dermal or systemic toxicity was observed.

Teratogenicity - Teratology Screen in Rats:
NOEL = 1,500 mg/kg/day (highest dose tested).

Mutagenicity
Salmonella/Mammalian-Microsome Plate Incorporation Mutagenicity Assay (Ames Test): Negative

Chromosomal Aberrations (CHO Cells): Negative

Unscheduled DNA Synthesis (Rat Primary Hepatocytes): Negative

Mouse Lymphoma Forward Mutation Assay: Negative without metabolic activation

In Vivo Mouse Micronucleus Assay: Negative

Salmonella/Mammalian-Microsome Reverse Mutation Assay: Negative

2. Studies on Scythe end-use Product Formulation

Acute Toxicity

Acute Oral LD_{50} (Rat):	>5000 mg/kg (Highest Dose Tested)
Acute Dermal LD_{50} (Rat):	>2000 mg/kg (Highest Dose Tested)
Acute Inhalation LC_{50} (Rat):	>5.29 mg/L
Dermal Irritation (Rat):	Moderately Irritating
Eye Irritation (Rabbit):	Severely Irritating
Skin Sensitization (Guinea Pig):	Not sensitizing

Toxicity tests are used to set worker safety standards. Rapid degradation in field and low mammalian toxicity translates to higher safety standards for the end-user. For agricultural uses that fall under the Worker Protection Standard (WPS), all formulations of Scythe (Pelargonic Acid –active ingredient) are labeled with the most current WPS worker protective equipment and re-entry interval recommended by EPA.

(e) Effects on soil organisms, crops, or livestock.

Laboratory studies performed indicate Pelargonic acid is rapidly and quantitatively degraded in the soil environment to existing background levels by microorganisms within a period of two days. These microorganisms and other flora and fauna use Pelargonic acid as a fatty acid source of nutrients and therefore Pelargonic acid and the formulation Scythe would present minimal toxicity to non-target organisms.

Pelargonic acid's low potential for environmental impact is discussed further in Section 9(b) under Toxicity and Environmental Persistence

Pelargonic acid has been detected to naturally occur in a variety of foods. In mammalian systems, fatty acids like Pelargonic acid are subject to β-oxidation which reduces the compound of many chain lengths by the sequential removal of two carbon units as acetyl-CoA. In addition the product does not pose any additional risk, since the inert ingredients (from EPA list 4) are of low toxicity to humans and wildlife. This is clearly demonstrated by the toxicology studies conducted on both the active substance and the formulated product.

Pelargonic acid and Scythe is a contact, non-selective, broad spectrum foliar-applied herbicide. This product will only control actively growing emerged green vegetation and requires thorough spray coverage of the treated weed . This product is not translocated. It will burn only those green plant parts that are coated with the spray solution. As such, if an applicator follows the label and intended uses then adjacent nontarget plants will be minimally affected. Typically if Pelargonic acid spray drift occurs symptoms will be no more severe than leaf spotting.

10. Safety information about the substance.

A Material Safety Data Sheet (MSDS) is attached in Appendix C. Hazardous Substances Data Bank Report from the National Institute of Health is attached in Appendix E.

11. Research information about the substance that includes comprehensive substance research reviews and research bibliographies, including reviews and bibliographies that present contrasting positions to those presented by the petitioner in supporting the substance's inclusion on or removal from the National List.

After a search of databases, bibliographies, and online, no specific articles were uncovered that present contrasting positions on the use of Pelargonic acid as a natural herbicide. Since its introduction in 1997 several reviews were published on Scythe's quick burn-down affect (within a couple of hours) and the synergistic effect, observed when Scythe is tank mixed with glyphosate as a penetration aid. Pelargonic acid is a natural fatty acid present in some soils, plants, animals and in food and has resulted in numerous individual studies within and outside of Dow AgroSciences. Appendix D includes a copy of the literature search conducted on published information available through March 18, 2005. Please feel free to request a more focused literature search if needed.

A few specific articles are attached to provide a representation of what is available in the published literature (Appendix E).

1. "Degradation of Fatty Acids in Lawn Soil, " Mozel and Nijolt (unpublished study)
2. "Fate of Capric and Pelargonic Fatty Acids in Soil," Mozel, Nijholt, and McHarg (unpublished study)

3. Savage, S. and P. Zorner, 1996, Use of Pelargonic Acid as a weed management tool. Abstract, California Weed Sci. Soc.
4. EPA Fact Sheet on Pelargonic acid. Additional information is attached to this fact sheet on the EPA web site
5. Sustainable Small-scale Nursery Production Horticulture Systems Guide `http://attra.ncat.org/attra-pub/PDF/nursery.pdf pg 12`
6. "Strategies for the Use of Natural Products for Weed Management;" Duke, S. O., et al., Journal of Pesticide Science 27: 298-306, 2002.
7. "Review Biopesticides: a review of their action, applications and efficacy;" Copping, L. G., Menn, J. J., Pest Management Science 56: pg. 659, 2000.
8. Hazardous Substances Data Bank (HSDB), a database of the National Library of Medicine's TOXNET system (http://toxnet.nlm.nih.gov) on February 2, 2005.

12. A "Petition Justification Statement"' which provides justification for the inclusion of Pelargonic Acid and Related C6-C12 Fatty Acids (the active ingredient in Scythe Herbicide) on the National List.

Despite the fact that organic farmers employ a variety of methods including flaming, hot water treatments, solarization, cultivation, mowing, mulching, and cover crops to control weeds, weed management is still consistently ranked as one of the most important production problems in organic agriculture(12). Weeds are considered a significant problem because they decrease crop yields and quality by increasing competition for soil nutrients, sunlight and water while serving as a friendly harbor for plant diseases and/or pests.

Pelargonic Acid and Related C6-C12 Fatty Acids compliments cultural and biological weed management practices.

The inclusion of Pelargonic acid to the National List will provide organic farmers with an effective tool in the management of weeds in organic crop production. Not all methods of weed management are practical for every growing condition, therefore it is imperative that the farmer understand weed biology and ecology of the land being farmed and have at their disposal a number of methods to control the expected and unexpected weeds that emerge. For example cultivation is effective in controlling some weeds and occasional passes through the field have been documented to build soil humus and help in the release of nutrients. Unfortunately cultivation cannot be used in all occasions. Deep cultivation may endanger the roots of the crop, expose new weedseed for germination, and frequent passes may compact the soil. With the current rise in fuel prices the cost of trips through the field may become prohibitive for certain crops. Ultimately the more tools the farmer has to address their weed management problems, the better they can find the most cost effective best fit for their current weed management issue.

Pelargonic acid compliments current organic weed management practices because it quickly knocks down and eliminates weeds without disrupting the existing soil layer. In certain situations, methods that kill the weed (like hand hoeing and mechanical cultivation) but disrupt the soil surface expose new weed seeds in the soil seedbank to sunlight which in many cases triggers germination and a repeat of the reproductive cycle. This trend is observed in high input crops like lettuce, grapes, and strawberries where manual weeding is implemented several times throughout the growing season. Methods like manual weeding that disrupt the soil surface also increase the chance of soil erosion, soil compaction, dust particulate pollution, and loss of soil moisture.

Specifically, Pelargonic acid is the active ingredient in a broad spectrum non-selective herbicide known as Scythe and is particularly effective at higher use rates. Its activity is strictly contact foliar in that only directly sprayed portions of the plant are effected. Pelargonic acid is not translocated, therefore desirable species will not be seriously effected if a directed application is used. If part of a desired plant is mistakenly sprayed only the area sprayed will be effected not the whole plant. Pelargonic acid efficacy requires full coverage of the target weed by the spray solution. There is no activity through volatilization and little if any effect at low spray volumes. Pelargonic acid will not damage plant tissues which are significantly woody or which are otherwise protected from spray contact. For this reason it is safe for application around woody perennial plants and for intentional suckering as in viticulture management. Also because of this feature Pelargonic acid is the most effective for the control of seedling weeds and has only short-term activity against larger plants or perennial species which can regrow from tubers, rhizomes or other such protected structures. Pelargonic application at high total spray volumes results in visible effects on most species within hours. Because of the rapid activity - when Pelargonic acid is in solution – an application is virtually unaffected by subsequent rain or irrigation in as little as 30 minutes after application. Pelargonic acid has no soil activity. Therefore it can be used any time prior to emergence of the desirable species. For this reason Pelargonic acid is well suited for seedbed or site preparation.

An advantage to Pelargonic acid is that larger-scale weeding can be accomplished with fewer personnel. This ability will free up personnel for the more delicate hand weeding jobs within the rows and other more labor intensive tasks.

Pelargonic Acid is safe for workers and field environments.

Excessive manual weeding may cause repetitive stress injuries increasing workman's comp claims and grower liability. In California Cal/OHSA recently (9/23/04) adopted a regulation that restricts hand weeding. While organic growers are exempt from most of the regulations it does require organic growers to provide safety equipment and additional rest time for laborers weeding which will add additional cost to the task. Substituting Pelargonic Acid for some applications with thermal weed control systems (propane flaming and hot water) may reduce the risk of operator injury.

Pelargonic Acid and Related C6-C12 Fatty Acids are fatty acids naturally found in many food crops. Research has shown that Pelargonic acid exists in background levels in certain soil types and is found throughout the human and animal food supply. Pelargonic acid was given GRAS status by FEMA (1965) and is approved by the FDA for food use (21CFR 172.515). A safety level of 20 ppm was approved by The Council of Europe,

(1975) for Pelargonic acid on the list of flavoring substances that may be added to foodstuffs without hazard to public health.

In summary, Pelargonic Acid is a fatty acid that exists naturally in the environment and food supply. It is non-toxic to mammals and other non-target organisms with no residual activity in the field. It does not leach, contaminate or accumulate in the soil or water and breaks down rapidly in the environment, usually within two days by microbial digestion. Pelargonic Acid's broad spectrum and rapid burn-down activity on green tissue will provide a powerful weed management tool to the organic farmer. Pelargonic acid is effective on green plant tissue only when it is in liquid form. It has no residual action and is therefore flexible and safe for many uses within/around the field, pasture, greenhouse, golf course, and home.

Through contact with organic growers in the field, we find a need for an effective tool to address weed management issues in organic crop production. Florida organic citrus growers responded overwhelmingly in a sector survey that weeds were the most difficult challenge in organic crop production management. Additionally, these growers expressed that the highest priority research needs to focus on weed management solutions. (13) Organic growers have also communicated to Dow AgroSciences their desire for an effective tool that would increase their effectiveness in the management of weeds (see letters from growers in Section F). Some of their comments are excerpted below:

- Sergio Casillas of Tanimura and Antle of Salinas, CA who currently manages 1,200 acres of organic vegetables states, "the organic grower at this time has very few options on herbicides that can be used. There are some acids that can be used, but they are not very effective. As you can imagine, hand labor is very expensive along with the liability that goes with it."
- Berny Borges of Monterey Pacific who manages 200 acres of organic wine grapes states, "Weed control is the most cost prohibitive part of organic farming… Weed control using mechanical tools eventually leads to soil compaction form hard pans at low depths below the grape vines. The hard pans once formed can never be broken up because of the narrow row spacing between the vines. The only other alternative is hand hoeing."
- Ramy Colfer of Mission Organics/ Earthbound Farms who farms over 5,500 acres of lettuce and leafy organic produce states, "Organic growers presently do not have an herbicide that is as effective and economical as Scythe. It would be a large improvement to our weed management program to be able to use the herbicide…"
- Mike Kennedy of Kennedy Farm Services who manages 4,000 acres of organic vegetables states, "Weed control on this ground is a serious issue for the growers, Cinnamon oil is available , but its effectiveness is poor. Flaming is often used , but on a limited basis based on both cost and danger to the applicators."
- James "Pebble" Smith, the grower Rep for Fetzer Wineries states, "we just gave a three day course to our growers on the challenges of Organic farming and there was a unanimous belief that the biggest challenge was weeds,….All that was available was acetic acid and clove oil and they were both expensive, stinky, and not very effective."

References:

(1) "Phytotoxic Activity of Middle-chain Fatty Acids II: Peroxidation and Membrane Effects," Lederer, B., et al., Pesticide Biochemistry and Physiology, 2004. 80: 151-156.

(2) "The Organic Acid Composition of Calluna Heathland Soil with Special Reference to Phyto- and Fungitoxicity;" Jalal and Read, Plant and Soil, Vol. 70, 1983, pages 257-272.

(3) "Degradation of Fatty Acids in Lawn Soil;" Mozel and Nijolt

(4) "Fate of Capric and Pelargonic Fatty Acids in Soil;" Mozel, Nijholt, and McHarg

(5) "Certain Fatty Acids and Hexadecylamine as Nematocides;" Loos, C.A., Plant Disease Reporter, 1958. 42 (10): 1179-1186.

(6) "Environmental Fate of Mineral, Vegetable and Transesterified Vegetable Oils;" Cornish, A. *et al.*, Pesticide Science 1993. 37.173-178.

(7) "Utilization of Medium-Chain Triglyceridies by Neonatal Piglets: II. Effects of Odd-Chain Triglyceride Consumption Over First 2 Days of Life on Blood Metabolites and Urinary Nitrogen Excretion;" Odle, J., Benevenga, N. J., and Cranshaw, T. D., Journal of Animal Science 1989. 67: 3340-3351.

(8) "Lipid Composition of Concord Grapes;" Higgins and Peng, American Journal of Enol. Viticulture, Volume 27, No. 1, 1976, pages 32-35.

(9) "Volatile Fatty Acids in flavors of Potatoes Deep-Fried in a Beef Blend;" Kim and Lindsay, JAOCS, Volume 69, Number 5, May 1991, page 294.

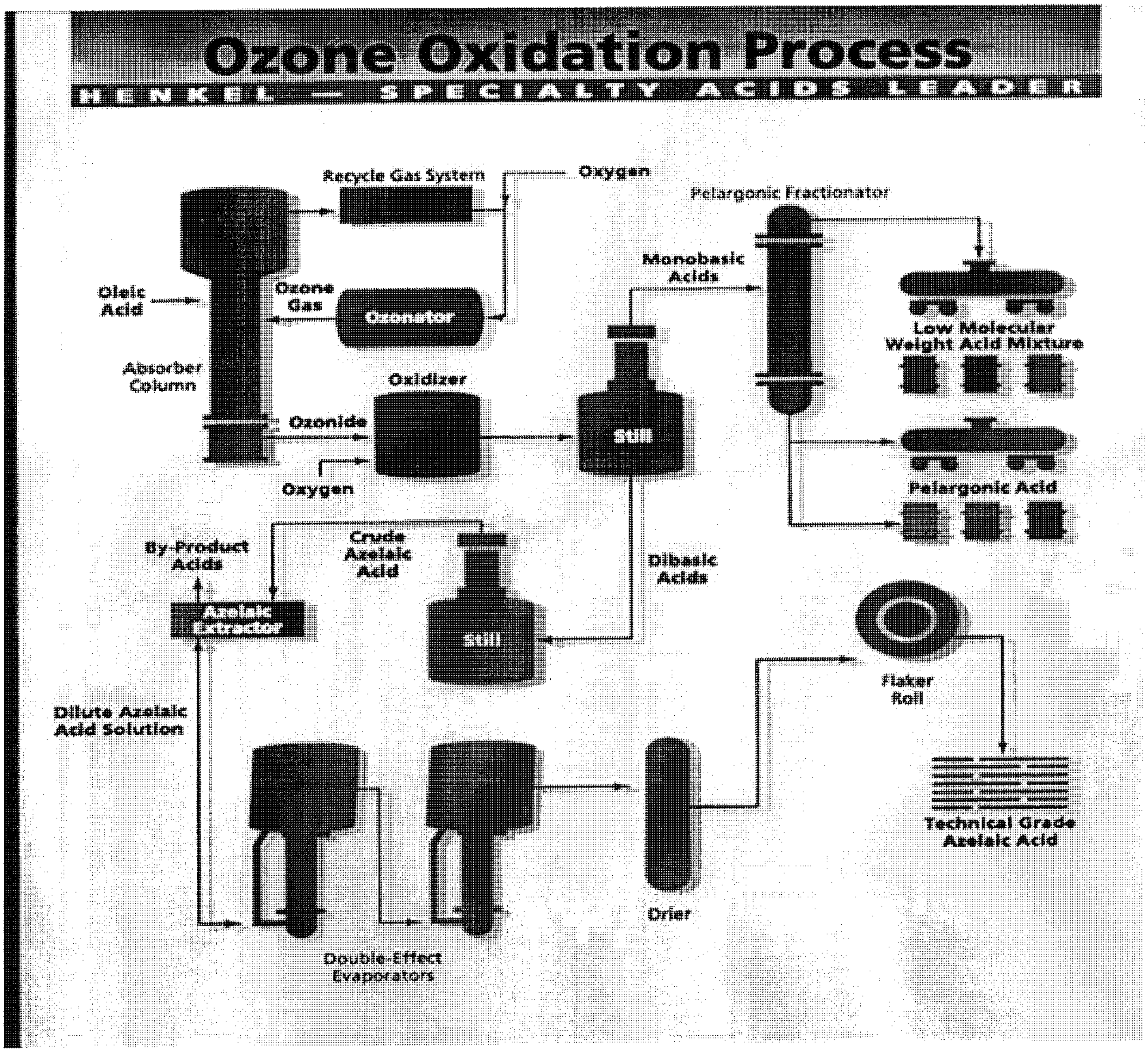
(10) "Method for the Quantitative Analysis of Volatile Free and Total Branched-Chain Fatty Acids in Cheese and Milk Fat;" Ha and Lindsay, Journal of Dairy Sciences, Volume 73, pages 1988-1999.

(11) "The Occurrence and Function of Short Chain Length Fatty Acids in Plants;" Berrie et al., Plant Science Letters, Volume 6, 1975, Pages 163-173.

(12) "Status and Preliminary Research on Non-Synthetic Herbicides for Organic Production;" James J. Ferguson and Carlene A. Chase Horticultural Sciences Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida., HS1003 January 2005 `http://edis.ifas.ufl.edu/HS247#TABLE 4`

(13) "Florida Organic Citrus Sector: Results of a 2003-4 Study;" Kevin Athearn, Organic Farming Research Foundation, http://www.ofrf.org/publications/Grant%20reports/03.f.09.Athearn.pdf

Appendix A


Ozone Oxidation Process
HENKEL — SPECIALTY ACIDS LEADER
Recycle Gas System
Oxygen
Pelargonic Fractionator
Oleic Acid
Ozone Gas
Ozonator
Monobasic Acids
Low Molecular Weight Acid Mixture
Absorber Column
Oxidizer
Ozonide
Still
Oxygen
Pelargonic Acid
By-Product Acids
Crude Azelaic Acid
Dibasic Acids
Azelaic Extractor
Still
Flaker Roll
Dilute Azelaic Acid Solution
Technical Grade Azelaic Acid
Drier
Double-Effect Evaporators

Appendix B

Base Label:

(Logo) Dow AgroSciences

Scythe®

Herbicide

For control or burndown of a broad spectrum of weeds on contact

Active Ingredients:
    Pelargonic Acid † 57.0%
    Related Fatty Acids (C_6-C_{12}) 3.0%
Other Ingredients †† 40.0%
Total 100.0%

† Contains 4.2 pounds of pelargonic acid per U.S. gallon.
†† Contains petroleum distillates.

The use of this product and select fatty acids alone and/or in combination with certain herbicides is covered in one or more of the following U.S. Patents: 5098467, 5106410, 4975110, 5096468, 5196044.

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 • Harmful If Absorbed Through The Skin

Do not get in eyes, on skin or on clothing. Avoid breathing spray mist. Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash clothing before reuse.

Personal Protection Equipment:

Worker Protection Standard (WPS) Uses: Some materials that are chemical-resistant to this product are listed below. If you want more options, follow the instructions for category E on an EPA chemical resistance category selection chart. Applicators and other handlers who handle this pesticide for any use covered by the Worker Protection Standard (40 CFR Part 170) - in general, agricultural uses are covered - must wear:

- Coveralls worn over short-sleeved shirt and short pants
- Chemical resistant-gloves such as barrier laminate, nitrile rubber, or neoprene rubber
- Chemical-resistant footwear plus socks
- Protective eyewear (goggles, face shield or safety glasses)

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

Non-WPS Uses: Applicators and other handlers who handle this pesticide for any use NOT covered by the Worker Protection Standard (40 CFR Part 170) - in general, only agricultural uses are covered - must wear:

- Long-sleeved shirt and long pants
- Chemical resistant-gloves such as barrier laminate, nitrile rubber, or neoprene rubber
- Protective eyewear (goggles, face shield or safety glasses)

User Safety Recommendations:

Users should:

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

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 further treatment advice.
If swallowed: Call a poison control center or doctor immediately for treatment advice. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-992-5994 for emergency medical treatment information.

Note to Physician: Contains petroleum distillates. Vomiting may cause aspiration pneumonia.

Environmental Hazards

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 when disposing of equipment washwaters or rinsate.

Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. Refer to label booklet under "Agricultural Use Requirements" in the Directions for Use section for information about this standard.

Refer to label booklet for additional Directions for Use including Storage and Disposal.

Notice: Read the entire label. Use only according to label directions. **Before using this product, read Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies at end of label booklet. If terms are unacceptable, return at once unopened.**

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994. If you wish to obtain additional product information, visit our web site at www.dowagro.com.

Agricultural Chemical: Do not ship or store with food, feeds, drugs or clothing.

EPA Reg. No. 62719-529 EPA Est. 00000-XX-00

®Trademark of Dow AgroSciences LLC
Dow AgroSciences LLC • 9330 Zionsville Rd • Indianapolis, IN 46268 U.S.A.

Net Contents __

Label Booklet:

(Logo) Dow AgroSciences

Scythe®
Herbicide

For control or burndown of a broad spectrum of weeds on contact

Active Ingredients:

Pelargonic Acid †	57.0%
Related Fatty Acids (C_6-C_{12})	3.0%
Other Ingredients ††	40.0%
Total	100.0%

† Contains 4.2 pounds of pelargonic acid per U.S. gallon.
†† Contains petroleum distillates.

The use of this product and select fatty acids alone and/or in combination with certain herbicides is covered in one or more of the following U.S. Patents: 5098467, 5106410, 4975110, 5096468, 5196044.

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.)

Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. Refer to label booklet under "Agricultural Use Requirements" in the Directions for Use section for information about this standard.

Refer to inside of this label booklet for additional Directions for Use including Storage and Disposal.

Notice: Read the entire label. Use only according to label directions. **Before using this product, read Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies at end of label booklet. If terms are unacceptable, return at once unopened.**

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994. If you wish to obtain additional product information, visit our web site at www.dowagro.com.

Agricultural Chemical: Do not ship or store with food, feeds, drugs or clothing.

EPA Reg. No. 62719-529 EPA Est. 00000-XX-00

®Trademark of Dow AgroSciences LLC
Dow AgroSciences LLC • 9330 Zionsville Rd • Indianapolis, IN 46268 U.S.A.

Net Contents __

Precautionary Statements

Hazards to Humans and Domestic Animals

WARNING

Causes Substantial But Temporary Eye Injury • Causes Skin Irritation • Harmful If Inhaled • Harmful If Absorbed Through The Skin

Do not get in eyes, on skin or on clothing. Avoid breathing spray mist. Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash clothing before reuse.

Personal Protection Equipment:

Worker Protection Standard (WPS) Uses: Some materials that are chemical-resistant to this product are listed below. If you want more options, follow the instructions for category E on an EPA chemical resistance category selection chart. Applicators and other handlers who handle this pesticide for any use covered by the Worker Protection Standard (40 CFR Part 170) - in general, agricultural uses are covered - must wear:

- Coveralls worn over short-sleeved shirt and short pants
- Chemical resistant-gloves such as barrier laminate, nitrile rubber, or neoprene rubber
- Chemical-resistant footwear plus socks
- Protective eyewear (goggles, face shield or safety glasses)

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

Non-WPS Uses: Applicators and other handlers who handle this pesticide for any use NOT covered by the Worker Protection Standard (40 CFR Part 170) - in general, only agricultural uses are covered - must wear:

- Long-sleeved shirt and long pants
- Chemical resistant-gloves such as barrier laminate, nitrile rubber, or neoprene rubber
- Protective eyewear (goggles, face shield or safety glasses)

User Safety Recommendations:

Users should:

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

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 further treatment advice.
If swallowed: Call a poison control center or doctor immediately for treatment advice. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-992-5994 for emergency medical treatment information.

Note to Physician: Contains petroleum distillates. Vomiting may cause aspiration pneumonia.

Environmental Hazards

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 when disposing of equipment washwaters or rinsate.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Read all Directions for Use carefully before applying.

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 or tribal agency responsible for pesticide regulations.

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 protection 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 12 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, include:

- Coveralls worn over short-sleeved shirt and short pants
- Chemical resistant-gloves such as barrier laminate, nitrile rubber, or neoprene rubber
- Chemical-resistant footwear plus socks
- Protective eyewear (goggles, face shield or safety glasses)

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 the treated areas until the sprayed area is dry.

Storage and Disposal

Do not contaminate water, food, or feed by storage or disposal.

Pesticide Storage: Keep container tightly sealed when not in use. Store only in original container in a dry place inaccessible to children and pets.

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

Container Disposal: Do not reuse empty container. Triple rinse, then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill or by incineration, or if allowed by state and local authorities, by burning. If burned, stay out of smoke.

General Information

Scythe® herbicide is a contact non-selective, broad spectrum, foliar-applied herbicide. This product will only control actively growing emerged green vegetation. It provides burndown of both annual and perennial broadleaf and grass weeds, as well as most mosses and other cryptogams. The degree of burndown and the longevity of control is less when the plants are inactive, mature, or biennial/perennial types. This product is not translocated. It will burn only those plant parts that are coated with spray solution.

This product is a non-volatile, emulsifiable concentrate. It can be applied through most standard or field type sprayers after dilution and mixing with water in accordance with label instructions. For best results, uniform and complete coverage of target plants is required.

Visible effects on most weeds occur within hours. This product does not damage mature, non-green, woody parts of plants. Cool weather following treatment slows the activity of this product and delays or reduces visual effects.

This product provides no residual weed control. Repeat treatments will be necessary for new plants emerging from seed or regrowth of treated vegetation. Should residual control be desired, use a product labeled for the use situation.

Mixing and Application Instructions

Apply spray solutions in properly maintained and calibrated equipment capable of delivering desired volumes. Avoid spraying or allowing drift to desirable plants. Always clean tank, pump, and line thoroughly with water after use.

Do not apply this product through any type of irrigation system.

Do not apply this product aerially.

Adjust spray droplet size to minimize drift and allow application to the intended exposure area only.

Mixing

This product mixes readily with water. To prepare the spray mixture, fill the mix or spray tank with three-fourths the required amount of water then add the proper amount of this product. Complete filling the mix or spray tank with the balance of water needed. Remove hose from tank immediately after filling to avoid siphoning back into the carrier source. Mix well.

During mixing and application, foaming of the spray solution can occur. A defoaming agent can be added to prevent excessive foaming. If application is intended in or around crops, the defoaming agent must be approved for such use.

Always determine compatibility of companion herbicides and tank additives prior to addition to the spray tank. Determine compatibility by performing a jar test using appropriate quantities of each material and water (see Tank Mixes).

For best results with backpack or other small tank applicators ensure thorough mixing of herbicidal solution at filling and during the spray operation. For sprayers without agitation, mix or shake regularly to maintain suspension. Without agitation, this product separates quickly out of the spray solution.

Boom Equipment

For best control or burndown of annual, biennial or perennial weeds using conventional boom equipment, use the indicated rate of this product in 75 to 200 gallons of spray solution per acre as a broadcast spray. Use lower delivery rates of 10 to 75 gallons per acre of spray solution when this product is used as a tank mix synergist with other foliar products (see Tank Mixes). As the density of weeds increase, increase spray gallonage within the indicated range.

Hand-Held and High-Volume Equipment

Use spray-to-wet applications of this product with knapsack and backpack sprayers, pump-up pressure sprayers, handguns, handwands, and other hand-held spray equipment and vehicle mounted high volume spray equipment. Apply spray solutions of this product to foliage of vegetation to be controlled. For most efficient use of spray mixture, spray all leaf surfaces uniformly and completely to wetness, but not to the point of runoff.

Selective Placement Equipment

Direct the herbicide solution onto weeds using a shielded applicator which employs a physical barrier to shield desirable vegetation from herbicide sprays. When applying this product through a shielded or directed applicator, follow spray volume instructions of the equipment or nozzle manufacturer.

Application Rates

Mix this product in the indicated proportions as listed below and deliver the spray solution through boom, high volume, or hand-held equipment.

Stand Alone Use

Use the following percentage solutions (volume/volume) to deliver 75 to 200 gallons of the spray solution per acre through boom, hand-held or high volume equipment.

- Use a 3-5% solution for control of annual weeds, mosses and cryptogams. Use the lower rate in the rate range for young, succulent and actively growing weeds and the higher rate for weeds greater than six inches in height or in the flowering stage. Use higher rate for control of mosses, lichens, and other cryptogams on structures and surfaces.
- Use a 5-7% solution for burndown of perennial herbaceous plant, weeds in a later stage of growth and control of sucker growth. Use the highest rate for perennial weeds at or beyond the flower stage or when the plants have "hardened".

- Use a 7-10% solution when maximum vegetative burndown, edging, or foliar trimming is desired.

Repeat application as required to maintain desirable level of weed control and to control plants emerging from seed and underground parts.

Tank Mixes

Tank mixing this product with other pesticides must be governed by the most restrictive label limitations and precautions. Do not exceed any label dosage rates. This product must not be mixed with any product containing a label prohibition against such mixing.

Always predetermine the compatibility of labeled tank mixtures of this product with other products in advance of application by mixing proportional quantities of all products and water in a container and watching for adverse reactions. When tank mixing, add formulations in the following sequence: (1) wettable powders; (2) flowable liquids; (3) emulsifiable liquids; (4) Scythe herbicide; (5) water soluble liquids; and (6) adjuvants.

This product is synergistic with certain postemergence herbicides. A mixture of this product and glyphosate have shown enhanced speed of top kill and improved control of numerous weed species and is protected under U.S. Patent 5,196,044.

See "Mixing and Application Instructions" section of this label for spray volume, equipment and procedures for tank mixtures.

Scythe plus Glyphosate Herbicides: To enhance the activity of glyphosate-containing herbicides such as Roundup, Rodeo, Touchdown, Glyphomax® or Glypro® herbicides, and accelerate burndown of target weeds, use the necessary amount of this product to reach a final concentration of 1-3% spray solution plus the labeled rate of the registered glyphosate product (see Rate Table). Lower rates in the rate range will provide less visible burndown effect. When this product is used as an additive and foliar burndown is not expected, mix the necessary amount to reach a final concentration of 0.25-1% spray solution plus the labeled rate of the glyphosate formulation. Adjust rates of both products according to label rates for desired level of control, weeds to be controlled, and conditions at application.

Scythe plus Other Foliar Herbicides: This product can enhance the activity of postemergence herbicides such as Touchdown herbicide and all formulations consisting of cyclohexanedione, sulfonylurea and imidazolinone herbicides when used as a tank mix additive. Use the necessary amount of this product to reach a final concentration of 1-3% spray solution plus the label rate of the companion product (see Rate Table). Lower rates in the rate range will provide less visible burndown effect. When this product is used as an enhancement additive and foliar burndown is not expected, mix the necessary amount to reach a final concentration of 0.25-1% spray solution plus the companion product. Adjust rates of products according to label rates for desired level of control, weeds to be controlled and conditions at application.

Scythe Plus Residual Herbicides: For burndown of vegetation followed by residual control of weeds emerging from seed or underground parts, mix this product with a labeled soil-active herbicide such as all formulations consisting of sulfonylurea, imidazolinone, triazine, dinitroaniline and acylurea herbicides. Follow the use instructions and application rates of the residual companion product plus: (See "Stand Alone" rates)

- 3-5% for annual weeds and vegetation
- 5-7% for perennial herbaceous and late stage annuals
- 7-10% for maximum vegetation burndown

Rate Table

Desired Volume Of Spray Solution (gallons)	Amount of Scythe for Following Percent Solution (Volume/Volume)				
	1%	3%	5%	7%	10%
1	1-1/3 fl oz	4 fl oz	6-2/3 fl oz	9-1/3 fl oz	13 fl oz
2.5	3 1/4 fl oz	9 2/3 fl oz	1 pt	1 3/8 pt	2 pt
5	6-2/3 fl oz	1-1/4 pt	2 pt	1-1/2 pt	2 qt
7.5	9 2/3 fl oz	1 3/4 fl oz	1 1/2 qt	2 1/4 qt	3 qt
10	13 fl oz	2-1/2 pt	2 qt	2-3/4 qt	1 gal

Use Methods

See the "Use Sites" section of this label to match the method of use with the crop or use situation.

1. **Vegetative Burndown:** General control of weeds for seedbed or site preparation, non-crop and around aquatic sites. Spot treatments may be used in crop and pasture situations.
2. **Directed and Shielded Sprays:** Applications may be made in and around desirable plants when contact of foliage and green bark is avoided.

3. **Prior to Emergence of Plants from Seed, Perennial Rootstocks, Corms and Bulbs:** Ensure applications are made before new growth or crop emerges from soil or damage will occur.
4. **Dormant or Post Harvest Spray:** For control of weeds growing in dormant turf or fields after this commodity has been harvested. Partially green growth will be killed or stunted.
5. **Sucker Control, Pruning and Trimming:** To burn back unwanted basal sucker growth on woody trees and foliage growth on vines, and excessive cane growth in brambles. Apply only to unwanted vegetative parts. Apply before suckers become woody.
6. **Harvest Aid and Desiccation:** To remove leaves of plants prior to harvest and/or burndown of weeds to facilitate harvest. Harvest aid and desiccation uses include applications to root and tuber vegetables, bulb vegetables and cotton only. Applications must be made no later than twenty-four hours prior to harvest (pre-harvest interval = 24 hours).
7. **Structural and Building Applications:** Apply to unwanted vegetation in and around buildings and structures. Application to walks, benches, walls, floors, roofs, or cooling pads for the control of moss and certain algae. A temporary residue or precipitate can result when used on some types of concrete, masonry, brick or stone.

Use Sites

Care must be exercised to avoid contact of spray with foliage of desirable turfgrasses, trees, shrubs, or other desirable vegetation since damage can result.

Best results are obtained when applications are made to young succulent weeds and when spray solutions cover all leaf surfaces. Mature, woody weeds are less susceptible. Repeat applications as needed to give desirable levels of weed control.

Select nozzles/pressure combinations that deliver large coarse droplets such as solid cones or flat fans at low pressures, and avoid nozzle/pressure combinations that generate fine particles or mist. If spraying areas adjacent to desirable plants, use a shield to help prevent spray from contacting foliage of desirable plants.

Reseeding or transplanting can occur in treated areas as soon as desirable levels of weed control are obtained.

Crop Uses and Use Methods

Use Methods: See the corresponding numbers in the "Use Methods" section under "General Information" for use descriptions and precautions.

Crop Group	**Crops**	Use Methods
Root Tuber and Perennial Vegetables	Asparagus, artichoke, beet, carrot, ginger, ginseng, horseradish, parsnip, potato, radish, rutabaga, sweet potato, turnip and yarn † Harvest Aid and Desiccation uses are approved only for root and tuber vegetables in this crop group.	1,2,3,4,6 †
Bulb Vegetables	Garlic, leek, onion, and shallot	1,2,3,6
Leafy Vegetables	Celery, cilantro, cress, endive, fennel, lettuce, parsley, rhubarb, spinach, Swiss chard	1,2
Cole or Brassica Crops	Broccoli, brussels sprouts, cabbage, cauliflower, collards, kale, kohlrabi, greens (mustard and turnip)	1,2,3
Legume Vegetable	Beans (*Phaseolus* spp. such as: field green, kidney, lima, mung, navy, pinto, snap, and wax beans) (*Vigna* spp. such as: black-eyed, Chinese longbean, cowpea, and southern pea) peas (*Pisum* spp. such as: garden, green, sugar, and snow peas), lentil, and soybean	1,2,3
Fruiting Vegetables	Eggplant, okra, pepper (bell, chili, sweet), pimento, and tomato	1,2,3
Cucurbits and Melons	Cucumber, gourd, muskmelon, cantaloupe, pumpkin, squash, and watermelon	1,2,3
Citrus	Grapefruit, kumquat, lemon, lime, orange, tangerine, and tangelo	1,2
Pome Fruit	Apple, crabapple, pear, and quince	1,2,5
Stone Fruit	Apricot, cherry, nectarine, peach, plum and prune	1,2,5
Small Fruit, Berries, and Grapes	Blackberry, blueberry, boysenberry, cranberry, currant, dewberry, grape (all types), loganberry, olallieberry, raspberry, and strawberry	1,2,3,5
Nuts	Almond, brazil nut, chestnut, filbert, macadamia, pecan, pistachio, and walnut	1,2,5
Tropical and Other Fruit	Avocado, banana, coconut, date, fig, guava, kiwi, mango, olive, persimmon, papaya and pineapple	1,2,5
Field Crops and	Barley, buckwheat, canola, corn (field,	1,2,3,6 †

Cereal Grains	popcorn, and sweet corn), cotton, cowpea, millet, oat, peanut, rice, rye, safflower, sorghum, sugarcane, sunflower, and wheat † Harvest Aid and Desiccation uses are approved only for cotton within this crop group.	
Forages and Pasture Grasses (Forage or Seed)	Alfalfa, clovers, trefoil, vetch, bromegrass, fescue, bluegrass, lespedeza, ryegrass, sudangrass, timothy, range grasses, and crops grown for livestock feed	1,3,4
Herbs & Spices	Anise, basil, caraway, chive, cumin, curry, dill, fennel, oregano, mints, rosemary, sage, savory, sweet bay, tarragon, thyme and wintergreen	1,2,3,4
Beverage and Specialty Crops	Cocoa, coffee, hops, tea, tobacco, and jojoba	1,2,5

Non-Crop Use Sites and Use Methods

Use Methods: See the corresponding numbers in the "Use Methods" section under "General Information" for use descriptions and precautions.

Non-Crop Group	**Non-Crop Use Sites**	Use Methods
Turf, Flowers, Bedding and Landscape Plants	Turfgrass (maintenance, sod or seed production), bedding plant, flowers, and ornamentals	1,2,3,4,5,6
Trees and Shrubs	Christmas trees, forest and commercial trees, landscape trees, nursery trees or shrubs, and fiber farms	1,2,5
Greenhouse and Indoor Use	All crops, plants, and structures	1,2,3,7
Non-Crop, Industrial, and Public Areas	Farmstead, homestead, fallow land, storage areas, schools, paved areas, rights-of-way (*e.g.*, road, railroad, utilities), parking lots, recreation areas (*e.g.*, athletic fields, campgrounds, golf courses, playgrounds), walks, industrial sites (*e.g.*, lumberyard, tank farms, buildings).	1,2,7
Structures, Buildings, and Walkways	Bench, deck, equipment, floor, roof, wall, walks, and evaporative cooling pads.	7
Dry Aquatic Sites, Dry Drainage Systems	Applications must be made 72 hours prior to reflooding of dry aquatic sites. Dry	1,7

and Around Aquatic Sites	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.	

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

Dow AgroSciences warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. Dow AgroSciences MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

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, 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 Dow AgroSciences 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 Dow AgroSciences' 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, Dow AgroSciences shall not be liable for losses or damages resulting from handling or use of this product unless Dow AgroSciences is promptly notified of such loss or damage in writing. In no case shall Dow AgroSciences 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 Dow AgroSciences or the seller is authorized to vary or exceed the terms of the Warranty Disclaimer or this Limitation of Remedies in any manner.

®Trademark of Dow AgroSciences LLC
® Rodeo is a registered trademark of Monsanto Company under license to Dow AgroSciences LLC
EPA-accepted 09-21-2004

Appendix C

MATERIAL SAFETY DATA SHEET

Revision Date: August 7, 2003

Product Name:	**Scythe® Herbicide**
Mycogen Code:	MYX 6121
EPA Registration No.:	53219-7
Primary Hazards:	Skin and Eye Irritant
Contact:	Mycogen Corporation 9330 Zionsville Road Indianapolis, IN 46268
Emergency Telephone:	1-800-992-5994

SECTION 1 - MATERIAL IDENTIFICATION

INGREDIENT 1

Common Name:	Pelargonic Acid
Chemical Name:	Nonanoic Acid
Molecular Formula:	$C_9H_{18}O_2$
CAS Number:	112-05-0
Percent:	57%

INGREDIENT 2

Common Name:	Paraffinic petroleum oil
Chemical Name:	Non Applicable (mixture
Molecular Formula:	Non Applicable (mixture)
CAS Number	64741-88-4
Percent:	30%

INGREDIENT 3

Common Name:	Emulsifies and other short chain fatty acids
Chemical Name:	Trade Secret
Molecular Formula:	Trade Secret
CAS Number:	Trade Secret
Percent:	13%

SECTION 2 - PHYSICAL DATA

Boiling Point:	230 - 237°C (atmospheric pressure)
Melting Point:	12.5°C
Vapor Pressure:	20 mm Hg @ 153°C
Specific Gravity:	0.900
Solubility in Water:	Emulsifiable in water
Appearance:	Colorless to faint yellow liquid
Odor:	Wax-like odor
pH:	3.75 (1% solution in distilled water)

SECTION 3 FIRE AND EXPLOSION DATA

Flash Point:	>200°F
Method:	Pensky Martine Closed Cup
Extinguishing Media:	Use water spray, dry chemical, foam or carbon dioxide.

SECTION 3 FIRE AND EXPLOSION DATA (Cont)

Special Fire Fighting Procedures:	Wear self-contained breathing apparatus when fire fighting in confined area.
Unusual Fire and Explosion Hazards:	Foam or Water can cause frothing.

SECTION 4 - REACTIVITY

Stability:	Stable
Hazardous Poly-merization	None likely.
Materials to Avoid:	Oxidizing agents.
Hazardous Decomposition Products:	Decomposition may produce carbon dioxide and carbon monoxide.

SECTION 5 - HEALTH HAZARD

Primary Route of Entry:	Dermal, Inhalation.
Exposure Limit:	TLV: 5 mg/m^3 (Ingredient 2).
Corrosivity:	Not Corrosive.
Skin/Eye Irritation:	Moderate skin, severe eye irritant
Sensitization:	Not a sensitizer.
Effects of Overexposure:	Prolonged or repeated exposure may be irritating to skin, eyes, and mucous membranes. Highly irritating to eyes.

Toxicity: None of the components of this product are listed as carcinogenic by NTP, IARC, or OSHA

Acute Studies

Oral LD50 (Rat):	> 5000 mg/kg (low toxicity)
Dermal LD50 (Rabbit):	> 2000 mg/kg (low toxicity)
Inhalation LC50 (Rat):	> 5.29 mg/L (4 hour) (low toxicity)

SECTION 6 - FIRST AID

Emergency First Aid Procedures:

If swallowed:	Call a doctor or get medical attention. Do not induce vomiting. Do not give anything by mouth to an unconscious person. Drink promptly a large quantity of milk, eggwhites, gelatin solution, or if these are not available, drink large quantities of water. Avoid alcohol.
If on skin:	Wash with plenty of soap and water. Get medical attention if irritation persists.
If in eyes:	Hold eyelids open and flush with a steady, gentle stream of water for 15 minutes. Get medical attention if irritation persists.
Note to Physician:	Contains petroleum distillates. Vomiting may cause aspiration pneumonia.

SECTION 7 - SPILL, LEAK AND DISPOSAL PROCEDURES

Steps To Be Taken In Case Material Is Released Or Spilled:

Do not breath vapor. Do not handle in confined spaces without adequate ventilation. If inadequate use suitable respirator. Avoid contact with skin and eyes.

Contain leaking liquid with sand, earth or other absorbent and place in a clean container for disposal.

Waste Disposal Method:

Waste, including spills or rinsates, and leftover pesticide that cannot be used according to label instructions must be disposed of according to applicable federal, state, and local procedures.

SECTION 8 - SPECIAL HANDLING

Clothing:	Wear long-sleeved shirt and long pants, and shoes plus socks.
Respiratory Protection:	Ensure good ventilation. Specific respiratory protection should not be necessary.
Protective Gloves:	Wear chemical resistant-gloves such as barrier laminate, nitrile rubber or neoprene rubber.
Eye Protection:	Protective eyewear such as chemical safety goggles should be worn.

Although general guidance has been provided, the degree of protection required in a particular situation depends on factors such as concentration and duration. More detailed advice on protective devices is available from Mycogen.

SECTION 9 - SPECIAL PRECAUTIONS

Precautions To Be Taken In Handling And Storing:

Keep in original container, tightly closed in a safe place.
Empty container completely and dispose of safely.
Wash any contamination from skin or eyes immediately.
Remove any heavily contaminated clothing immediately.
Wash hands and exposed skin before eating, drinking, or smoking and after working with product.

Environmental Hazards:

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

SECTION 10 - SHIPPING REGULATIONS

DOT Shipping Name:	None
DOT Hazard Class/ I.D. No.:	None
DOT Label(s):	None
Freight Classification:	Compounds, Tree or Weed Killing, Herbicides, N.O.I. NMFC 50320. Class 60

SARA Title III Hazard Classification:	
Immediate (acute) Health:	Yes
Delayed (chronic) Health:	No
Fire:	No
Sudden Release of Pressure:	No
Reactive:	No

National Fire Protection Association Rating:	
Health:	2
Flammability:	1
Reactivity:	0

This information is provided in good faith but without express or implied warranty.

MYCOGEN CORPORATION

Scythe® is a registered trademark of gen Corporation

Appendix D

Dow AgroSciences

INFORMATION MANAGEMENT CENTER/LIBRARY

SEARCH REPORT

DATE:	March 18, 2005
TITLE:	Reviews on Pelargonic Acid
REQUESTER:	Robert Sibley
SOURCES:	Ag and Biological Databases on STN
COMMENTS:	A search was run to retrieve reviews on pelargonic acid, also called Scythe, nonanoic acid, nonoic acid, pelargonate or 112-05-0.
PREPARED BY:	Anne Gregg, 306 Bldg/C-2, Indianapolis
PHONE:	+1 317-337-3518

TO REQUEST:

Books/Journal Articles/Patents/Translations:
By Phone - IMC at 317-337-3691
By Email - Send to "Dow AgroSciences GRIMC"
By Intranet - http://crossrnd.el.dow.com/imc98/copyforma.htm

DERBI Reports:
By Phone: - Derbi Operations at 317-337-4667
By Email - Send to "DERBI Operations"
By Intranet - http://crossrnd.el.dow.com/derbi98/derbi/request_form.htm

```
L52  ANSWER 1 OF 66  BIOSIS  COPYRIGHT (c) 2005 The Thomson Corporation
on STN
AN   2004:180518  BIOSIS
DN   PREV200400182731
TI   Nonanoic acid: An experimental irritant.
AU   Wahlberg, Jan E.; Lindberg, Magnus [Reprint Author]
CS   Department of Occupational and Environmental Dermatology,
Norrbacka,
     SE-171 76, Stockholm, Sweden
     magnus.lindberg@smd.sll.se
SO   Contact Dermatitis, (September 2003) Vol. 49, No. 3, pp. 117-123.
print.
     ISSN: 0105-1873 (ISSN print).
DT   Article
LA   English
ED   Entered STN: 7 Apr 2004
     Last Updated on STN: 7 Apr 2004
AB    Irritant contact dermatitis is defined as a non-immunological skin
      reaction following exposure to various chemical, mechanical and
      physical factors.  It is known that the skin response to irritants
      depends on the irritant applied and differs between chemically
      different irritants. Sodium lauryl sulfate (SLS) is an anionic
      detergent and the most frequently used substance in experimental
      irritant contact dermatitis.  In 1980, it was suggested that
      nonanoic acid (NNA) could be used as a positive control when patch
      testing.  Since then, NNA has been used as an experimental
      irritant in several studies and has been used as a chemically
      different substance compared to SLS.  The present article presents
      a review of the application of NNA in studies on skin irritancy
      and experimental irritant contact dermatitis.


L52  ANSWER 4 OF 66  CABA COPYRIGHT 2005 CABI on STN
AN   78:15730  CABA
DN   19780365956
TI   Levels of short-chain fatty acids and of abscisic acid in water-
stressed
     and non-stressed leaves and their effects on stomata in epidermal
strips
     and excised leaves
AU   Willmer, C. M.; Don, R.; Parker, W.
CS   Stirling University, Stirling, UK.
SO   Planta, (1978) Vol. 139, No. 3, pp. 281-287. 31 ref.
     ISSN: 0032-0935
DT   Journal
LA   English
ED   Entered STN: 19941101
     Last Updated on STN: 19941101
AB    Endogenous levels of straight-chain saturated fatty acids (C6-C11)
      and abscisic acid increased in leaves of certain plants, including
      Phaseolus vulgaris, under water stress. At a concentration of 10-
      3M, externally applied nonanoic acid, decanoic acid, and
      particularly undecanoic acid and all-trans-farnesol increased cell
      leakage in beetroot root tissue. Effects on stomata movement in
      other species are also described.
```

L52 ANSWER 5 OF 66 HCAPLUS COPYRIGHT 2005 ACS on STN
AN 2004:676021 HCAPLUS
DN 141:381704
TI A survey of the combustion behavior of heterogeneous mixtures containing different inert and energetic materials
AU Baschung, B.; Hensel, D.; Grune, D.
CS ISL, French-German Research Institute of Saint Louis, Saint-Louis, 68301, Fr.
SO International Annual Conference of ICT (2004), 35th, 25/1-25/15 CODEN: IACIEQ; ISSN: 0722-4087
PB Fraunhofer-Institut fuer Chemische Technologie
DT Journal; General Review
LA English
AB A review. For the last 25 yr up to the present day, great worldwide efforts have been undertaken to produce new effective mixts. of energetic materials for all kinds of applications. The essential objectives of such developments are high energy per unit of mass, high effectiveness of the combustion gases, stable burning during their operation, less vulnerability and, last but not least, environmentally friendly characteristics ("clean" propellants). This paper reports the results of burning expts. carried out at ISL during the last 25 yr with the heterogeneous energetic mixts. mentioned above. The main compds. of the ten selected different mixts. are Al (nanoparticle), CAB, DINA, HMX, HTPB, IDP, KNO3, Nc, Ngl, NQ, Pu, RDX, and TAGN. Their burning behavior has been investigated in the pressure range from a low pressure (< 50 MPa) up to 1 GPa. The burning behavior results and the properties of the mixts. investigated are discussed. In addition, the knowledge about those energetic materials acquired during the investigations is emphasized. The pressure-dependent burning behavior can often be calculated by means of Vieille's burning law within mixture-dependent pressure limits. Non-dangerous mixts. reduce their pressure-dependent burning rate at high pressures (d2r/dt2 becomes neg.). There exist mixture-dependent low-web limits for stable burning. Mixts. with several different crystalline components lead to an early decomposition of the grain during burning. The gases of high-performance seminitramine mixts. in general are highly erosive and therefore, not useful in practice. Components with needle-like crystals are not allowed, because they destroy the grain of the mixture during burning. The HTPB mass fraction of HTPB-bonded mixts. is limited between 12-16%. Aluminum nanoparticles lead to an abnormal burning behavior and open new doors in the future.

L52 ANSWER 6 OF 66 HCAPLUS COPYRIGHT 2005 ACS on STN
AN 2004:277885 HCAPLUS
DN 142:131661
TI The pyrolysis of tobacco ingredients
AU Baker, Richard R.; Bishop, Louise J.
CS Research and Development Centre, British American Tobacco, Southampton, SO15 8TL, UK

SO Journal of Analytical and Applied Pyrolysis (2004), 71(1), 223-311
CODEN: JAAPDD; ISSN: 0165-2370
PB Elsevier Science B.V.
DT Journal
LA English
AB Relationships between tobacco components and smoke products are complex and often difficult to unravel. Pyrolysis expts. have commonly been used to establish such relationships. However, unless they are performed under dynamic conditions that are relevant to those that occur during tobacco burning, results can be obtained which have little resemblance to those obtained during cigarette smoking. The relevance of pyrolysis expts. to the behavior of tobacco ingredients in a burning cigarette is considered. Based on the temperature, heating rate, oxygen levels and gas flow conditions that occur inside the burning zone of a cigarette, together with a review of relevant pyrolysis and smoking expts., a set of pyrolysis conditions has been developed that approximates those occurring in the pyrolysis region of the burning cigarette. The conditions include heating the sample at 30° s-1 from 300 to 900° under a flow of 9% oxygen in nitrogen. Expts. on the pyrolytic behavior of eleven relatively volatile substances under these conditions give results that are in good agreement with results from thirteen published studies in which cigarettes incorporating labeled versions of the substances were smoked. Subsequently, 291 single-compound tobacco ingredients have been pyrolyzed under this set of conditions, most of which are relatively volatile. This enables the behavior of these ingredients in a burning cigarette to be estimated in terms of intact transfer to mainstream smoke vs. pyrolytic decomposition It is predicted that almost a third of the substances would transfer to mainstream smoke at least 99% intact, and almost two-thirds would transfer 95% intact. Where pyrolytic decomposition does occur, the products are listed together with an estimate of the levels in smoke that would arise from the ingredient.

L52 ANSWER 7 OF 66 HCAPLUS COPYRIGHT 2005 ACS on STN
AN 2003:105690 HCAPLUS
DN 139:5796
TI Flavor characteristics of spray-dried skim milk powder
AU Shiratsuchi, Hideki
CS Div. Food Health Environment, Fac. Environmental Symbiotic Sci., Prefectural Univ. Kumamoto, 3-1-100, Tsukide, Kumamoto, 862-8502, Japan
SO Foods & Food Ingredients Journal of Japan (2003), 208(1), 26-45
CODEN: FFIJER; ISSN: 0919-9772
PB FFI Janaru
DT Journal; General Review
LA Japanese
AB A review. The volatile flavor compds. of skim milk powder have been investigated. Com. processed spray-dried skim milk was homogenized with water, and the volatiles were isolated by simultaneous steam distillation-extraction under reduced pressure (SDE) using di-Et ether as solvent. Major compds. were 48 hydrocarbons, 18 aldehydes, 20 ketones, 21 alcs., 29 fatty acids, 8 esters, 2 furans, 7 phenolic compds., 10 lactones, and 14 nitrogenous compds., which constituted over 99% of total volatiles

recovered. Most of them originated by breakdown of the major constituent of milk, especially fat to smaller, volatile chems. or their secondary reaction, or by transfer from the forage. To identify Contributors to sweet and milky odor attributes of spray-dried skim milk, the odor concentrate was fractionated by silica gel TLC and a preparative GC, nonanoic acid, decenoic acid, and dodecanoic acid were responsible for a sweet, aldehydic, fatty, and milky odor; undecanoic acid, a sweet, fatty, and butter-like odor, γ-undecalactone, γ-dodecalactone, a γ-lactone, δ-decalactone, and δ-undecalactone, a sweet, fragrant, and milky odor. On the other hand, to elucidate the compds. contributing to the off-flavor, the concentrate was fractionated by silica gel TLC and a preparative GC. Tetradecanol, having a content about 10 times higher in the off-flavored skim milk than in normal one, was responsible for a sickening and aldehydic odor. β-Ionone and benzothiazole were 76 and 37 times higher in the off-flavored skim milk, resp., and the former imparted a fragrant and hay like odor and the latter a sulfuric and quinoline-like odor. The mean contents of tetradecanal, β-ionone and benzothiazole in various skim milk powders which differ from each other in manufacturing lot were 20, 0.13 and 0.40 ppb for skim milk powders with normal flavor and 40, 0.62 and 0.80 ppb for those with off-flavor, resp. As a result of sensory evaluation of the skim milk powders by triangle difference test, the off-flavor was perceived when tetradecanal and β-ionone increased beyond 25 and 0.3 ppb, resp.

L52 ANSWER 9 OF 66 HCAPLUS COPYRIGHT 2005 ACS on STN

AN 2002:720857 HCAPLUS

DN 137:347772

TI Use of mechanism-based structure-activity relationships analysis in carcinogenic potential ranking for drinking water disinfection by-products

AU Woo, Yin-Tak; Lai, David; McLain, Jennifer L.; Manibusan, Mary Ko; Dellarco, Vicki

CS Office of Prevention, Pesticides, and Toxic Substances, Risk Assessment Division, U.S. Environmental Protection Agency, Washington, DC, USA

SO Environmental Health Perspectives Supplements (2002), 110(1), 75-87
CODEN: EHPSEO; ISSN: 1078-0475

PB National Institute of Environmental Health Sciences

DT Journal; General Review

LA English

AB Disinfection byproducts (DBPs) are formed when disinfectants such as chlorine, chloramine, and ozone react with organic and inorg. matter in water. The observations that some DBPs such as trihalomethanes (THMs), di-/trichloroacetic acids, and 3-chloro-4-(dichloromethyl)-5-hydroxy-2(5H)- furanone (MX) are carcinogenic in animal studies have raised public concern over the possible adverse health effects of DBPs. To date, several hundred DBPs have been identified. To prioritize research efforts, an in-depth, mechanism-based structure-activity relationship anal.,

```
        supplemented by extensive literature search for genotoxicity and
        other data, was conducted for ranking the carcinogenic potential
        of DBPs that met the following criteria: (a) detected in actual
        drinking water samples, (b) have insufficient cancer bioassay data
        for risk assessment, and (c) have structural features/alerts or
        short-term predictive assays indicative of carcinogenic potential.
        A semiquant. concern rating scale of low, marginal, low-moderate,
        moderate, high-moderate, and high was used along with delineation
        of scientific rationale.  Of the 209 DBPs analyzed, 20 were of
        priority concern with a moderate or high-moderate rating.  Of
        these, four were structural analogs of MX and five were
        haloalkanes that presumably will be controlled by existing and
        future THM regulations.  The other eleven DBPs, which included
        halonitriles (6), haloketones (2), haloaldehyde (1),
        halonitroalkane (1), and dialdehyde (1), are suitable priority
        candidates for future carcinogenicity testing and/or mechanistic
        studies.
RE.CNT  91      THERE ARE 91 CITED REFERENCES AVAILABLE FOR THIS RECORD
                ALL CITATIONS AVAILABLE IN THE RE FORMAT


L52  ANSWER 11 OF 66  HCAPLUS  COPYRIGHT 2005 ACS on STN
AN   2001:865917  HCAPLUS
DN   136:213780
TI   Evaluation of the potential effects of ingredients added to
cigarettes.
     Part 1: Cigarette design, testing approach, and review of
     results
AU   Carmines, E. L.
CS   Philip Morris U.S.A. Research Center, Richmond, VA, 23261-6583,
USA
SO   Food and Chemical Toxicology (2002), 40(1), 77-91
     CODEN: FCTOD7; ISSN: 0278-6915
PB   Elsevier Science Ltd.
DT   Journal
LA   English
AB    A testing program was designed to evaluate the potential effects
      of 333 ingredients added to typical com. blended test cigarettes
      on selected biol. and chemical endpoints.  Ingredients were
      incorporated into the test cigarettes as they are normally used in
      the manufacturing process.  The studies performed included a
      bacterial mutagenicity screen (Ames assay), a mammalian cell
      cytotoxicity assay (neutral red uptake), determination of smoke
      chemical constituents, and a 90-day nose-only smoke inhalation
      study in rats. Three pairs of test cigarettes were produced, each
      containing one of three different groups of ingredients.  In each
      pair, one of the cigarettes contained the normal approx. use level
      of the ingredients (low-level) and the other a 1.5-3 multiple of
      the normal use level (high-level).  Anal. of the test cigarettes
      for selected ingredients or markers indicated that the target
      application rates were achieved and that the cigarettes had been
      manufactured as intended.  Evaluation of cigarette performance
      indicated that the addition of the ingredients at high levels did
      not significantly alter the burning characteristics of the test
      cigarettes.  Specific details of the individual studies conducted
      as part of an ingredient evaluation program are discussed in Parts
      2-4 of this publication series (Food and Chemical Toxicol., 2002,
```

```
     40, 93-104; Food and Chemical Toxicol., 2002, 40, 105-111; Food
     and Chemical Toxicol., 2002, 40, 113-131).  The results of the
     smoke chemical studies indicated a reduction in the majority of
     the smoke constituents and a few isolated instances of increases
     when compared to the control cigarettes.  These smoke chemical
     changes, while statistically significant, were not supported by
     any significant alteration in the biol. effects of cigarette smoke
     normally seen with the bacterial mutagenicity assay, cytotoxicity
     assay or subchronic inhalation study.  Based on the results of
     these studies, it can be concluded that these ingredients added to
     tobacco do not add significantly to the overall toxicity of
     cigarettes.
RE.CNT  51     THERE ARE 51 CITED REFERENCES AVAILABLE FOR THIS RECORD
               ALL CITATIONS AVAILABLE IN THE RE FORMAT

L52  ANSWER 12 OF 66  HCAPLUS  COPYRIGHT 2005 ACS on STN
AN   2001:293293  HCAPLUS
DN   135:73082
TI   Structural enzymology of biotin biosynthesis
AU   Schneider, G.; Lindqvist, Y.
CS   Department of Medical Biochemistry and Biophysics, Scheelevagen 2,
     Karolinska Institutet, Stockholm, S-171 77, Swed.
SO   FEBS Letters (2001), 495(1,2), 7-11
     CODEN: FEBLAL; ISSN: 0014-5793
PB   Elsevier Science B.V.
DT   Journal; General Review
LA   English
AB    A review with 44 refs.  Over the last years, significant progress
      has been made in the understanding of the genetics and enzymol. of
      the biosynthetic pathway of the vitamin biotin.  The enzymes
      catalyzing the last four steps of this pathway, from pimeloyl-CoA
      to biotin, provide an ensemble of intriguing reaction mechanisms,
      which are presently being unravelled.  The three-dimensional
      structures for three of these enzymes are known and provide a
      framework to which on-going mechanistic studies can be related.
RE.CNT  44     THERE ARE 44 CITED REFERENCES AVAILABLE FOR THIS RECORD
               ALL CITATIONS AVAILABLE IN THE RE FORMAT

L52  ANSWER 13 OF 66  HCAPLUS  COPYRIGHT 2005 ACS on STN
AN   1998:783491  HCAPLUS
DN   130:111748
TI   Oleic acid oxidation using hydrogen peroxide in conjunction with
     transition metal catalysis
AU   Turnwald, S. E.; Lorier, M. A.; Wright, L. J.; Mucalo, M. R.
CS   Meat Industry Research Institute of New Zealand (Inc.), Hamilton,
N. Z.
SO   Journal of Materials Science Letters (1998), 17(15), 1305-1307
     CODEN: JMSLD5; ISSN: 0261-8028
PB   Kluwer Academic Publishers
DT   Journal; General Review
LA   English
AB    The oxidative cleavage of oleic acid to produce azelaic and
      pelargonic acids using H2O2 and 12-tungstophosphates or a
      molybdenum complex was reviewed with 9 refs.  A mechanism
      operative for the Mo complex was proposed.
RE.CNT  9      THERE ARE 9 CITED REFERENCES AVAILABLE FOR THIS RECORD
               ALL CITATIONS AVAILABLE IN THE RE FORMAT
```

L52 ANSWER 14 OF 66 HCAPLUS COPYRIGHT 2005 ACS on STN
AN 1998:97387 HCAPLUS
DN 128:129405
TI Non-food applications of fats and oils
AU Helme, J. -P.; Pages, X.; Morin, O.; Parmentier, J.
CS French Institute for Fats and Oils (ITERG), Pessac, F33600, Fr.
SO Oils-Fats-Lipids 1995, Proceedings of the World Congress of the International Society for Fat Research, 21st, The Hague, Oct. 1-6,
1995
(1996), Meeting Date 1995, Volume 3, 437-451 Publisher: P.J.
Barnes &
Associates, Bridgwater, UK.
CODEN: 65QOAT
DT Conference; General Review
LA English

AB A review with 34 refs. As a renewable resource, plant oils offer a small but important step toward reducing dependence on crude oil. For a long time the drying, semi-drying, and non-drying oils (bean, linseed, soybean, sunflower, safflower, and coconut) have been the main raw materials for the coating, paint and varnish industries. But now, consideration of international awareness of pollution (air, water, and soil) points to biodegradability and ecotoxicol. Indeed, the vegetable oils present tech. qualities brought by their different acid compns. and their specific structures. These oils are excellent bases for lubricants, pharmaceutical products, and other miscellaneous uses. We will examine the sectors offering new industrial applications: energy (vegetable oil-based fuel), polymers sector (obtained by polymerization, polycondensation, and polyaddn.), lubricant bases for application of active phytosanitary mols. in agriculture, cosmetics, and skin care products. For chemists, castor oil is an excellent model because of the large number of chemical reactions theor. possible on the hydroxyl group, the ester linkage, and the double bond, but until now only five castor oil derivs. have industrial markets. Projects concerned with using adhesive soy protein in non-food applications are on new silk-like fibers, hair care, paper coating and polymeric materials. Alkylpolyglycosides are a new category of mild, highly biodegradable surfactants manufactured by reacting fatty alcs. with carbohydrates in the presence of acid catalysts. These products represent a new generation of non-ionic surfactants. They have a pronounced electrolyte compatibility, stability in the alkaline pH range, low toxicity, high biodegradability under both aerobic and anaerobic conditions, as well as excellent skin compatibility. These properties highlight their suitability for use as surfactant and co-surfactant in cosmetic cleansers, hand dishwashing agents, liquid hand soaps, and special cleansers. Erucamide, a derivative of erucic acid, is the primary established market of high erucic acid oils (HEA). It is used as an anti-block and slip-promoting agent in the production and functioning of plastic films. Erucic acid can be cleaved to form brassylic acid (α-13 carbon acid) and pelargonic acid (α-9 carbon acid). Brassylic acid may be polymerized to form Nylon 1313, material having a low moisture absorption. The oleochem. industry is constantly searching for new routes for the preparation of oleochem. derivs. New

```
     manufacturing methods can allow for improvement in existing
     classes of materials, for example reduced manufacturing costs or
     improved access to novel material classes through new chemical
     The developing field of biotechnol. offers a cleaner chemical and
     higher specificity and selectivity.
RE.CNT  34     THERE ARE 34 CITED REFERENCES AVAILABLE FOR THIS RECORD
               ALL CITATIONS AVAILABLE IN THE RE FORMAT

L52  ANSWER 15 OF 66  HCAPLUS  COPYRIGHT 2005 ACS on STN
AN   1993:650253  HCAPLUS
DN   119:250253
TI   Neolipid enzymic synthesis: acylated aminopolyols
AU   Fontana, Jose D.; Beck, Roland; Baron, Madalena; De Almeida,
Eduardo R.
     A.; Nogoceke, Everson
CS   Dep. Biochem., Fed. Univ. Parana, Curitiba, 81.531, Brazil
SO   Applied Biochemistry and Biotechnology (1993), 39-40, 249-63
     CODEN: ABIBDL; ISSN: 0273-2289
DT   Journal; General Review
LA   English
AB   A review with 13 refs. on the enzymic coupling on amino alditols
     and medium-chain length fatty acids via the reverse action of a
     fungal lipase.  Model reactants and catalysts were glucamine (1-
     amino-1- deoxysorbitol = AmS), pelargonic (nonanoic) acid, and
     Lipozyme IM-20.  The reaction proceeded in the presence of dry or
     water-saturated apolar organic solvents such as hexane and carbon
     tetrachloride. Increased molar ratio of acyl donor to acyl
     acceptor allowed the esterification and the amidation reactions to
     proceed with no need of solvent addition  A broad specificity was
     found for Lypozyme reverse action in terms of both acyl acceptors
     and donors.


L52  ANSWER 16 OF 66  HCAPLUS  COPYRIGHT 2005 ACS on STN
AN   1993:602066  HCAPLUS
DN   119:202066
TI   Supercritical fluid extraction of muscle food lipids for improved
quality
AU   Bailey, Milton E.; Chao, Roy R.; Clarke, Andrew D.; Um, Ki Won;
Gerhardt,
     Klaus O.
CS   Dep. Food Sci. Hum. Nutr., Univ. Missouri, Columbia, MO, 65211,
USA
SO   ACS Symposium Series (1993), 528(Food Flavor and Safety), 117-37
     CODEN: ACSMC8; ISSN: 0097-6156
DT   Journal; General Review
LA   English
AB   Supercrit. CO2 (SC-CO2) was used to reduce the lipid of meat and
     the cholesterol of meat and beef tallow.  Lipids can be removed
     quant. from dired muscle foods by SC-CO2, but relatively high
     temps. are needed.  The use of SC-CO2 in conjunction with ethanol,
     adsorbents and multi-separators also reduced the cholesterol of
     beef tallow.  SC-CO2 was also used to concentrate volatile flavor
     compds. from beef and pork fat.  The volatile components in
     various extraction fractions were identified and quantitated. Data
     are presented along with a review of research on the use of
     supercrit. fluid extraction for improving meat product quality.
```

```
L52  ANSWER 21 OF 66  HCAPLUS  COPYRIGHT 2005 ACS on STN
AN   1987:182428  HCAPLUS
DN   106:182428
TI   Studies on the essential oils of the fruits from the genus Lindera
in the
     Lauraceae family
AU   Nii, Hiromichi
CS   Nagaoka Koryo Kenkyusho, Japan
SO   Koryo (1986), 152, 53-9
     CODEN: KORYAR; ISSN: 0368-6558
DT   Journal
LA   Japanese
AB    The composition of oils obtained from Lindera leaves, barks, etc.
      is review and the anal. of the fruit oils is presented.  The
      average yield of the fruit oils in 6 species was 1.77%.  Fifty-
      eight constituents, were identified.  The major constituents were
      myrcene  [123-35-3] 34.72, trans-β-ocimene  [3779-61-1] 14.58,
      germacrene D  [23986-74-5] 12.50, and α-phellandrene  [99-83-2]
      8.5%.


L52  ANSWER 22 OF 66  HCAPLUS  COPYRIGHT 2005 ACS on STN
AN   1986:496310  HCAPLUS
DN   105:96310
TI   Fatty acids, monoglycerides and sucrose esters as anticaries
agents
     review
AU   Schemmel, Rachel A.; Kabara, J. J.
CS   Dep. Food Sci. Hum. Nutr., Michigan State Univ., East Lansing, MI,
48824,
     USA
SO   AOCS Monograph (1985), 13(Pharmacol. Eff. Lipids 2), 51-8
     CODEN: AOMODZ; ISSN: 0731-4183
DT   Journal; General Review
LA   English
AB    A review, with 39 refs., of cariostatic properties of the title
      classes of compds., in particular, glycerol monolaurin and
      nonanoic acid.


L52  ANSWER 23 OF 66  HCAPLUS  COPYRIGHT 2005 ACS on STN
AN   1981:120758  HCAPLUS
DN   94:120758
TI   Pelargonic acid
AU   Leoci, B.; Romagnuolo, M.
CS   Italy
SO   Rassegna Chimica (1980), 32(5), 237-44
     CODEN: RACHAG; ISSN: 0033-9334
DT   Journal; General Review
LA   Italian
```

```
AB    A review with 140 refs.


L52  ANSWER 24 OF 66  HCAPLUS  COPYRIGHT 2005 ACS on STN
AN   1979:598758  HCAPLUS
DN   91:198758
TI   Monographs on fragrance raw materials.  Pelargonic acid
AU   Opdyke, D. L. J.
CS   Res. Inst., Fragrance Mat., Inc., Englewood Cliffs, NJ, 07632, USA
SO   Food and Cosmetics Toxicology (1978), 16(Suppl. 1), 839-41
     CODEN: FCTXAV; ISSN: 0015-6264
DT   Journal; General Review
LA   English
AB    A review with 44 refs. on pelargonic acid [Me(CH2)7CO2H]  [112-05-
      0] including toxicity, irritation, sensitization, metabolism,
      antitumor activity, pharmacol., and effect on enzymes.



L52  ANSWER 26 OF 66  HCAPLUS  COPYRIGHT 2005 ACS on STN
AN   1967:497580  HCAPLUS
DN   67:97580
TI   Development, results, and prospects of the cultivation of oil-
seeds in
     Poland
AU   Dembinski, Felicjan
CS   Landwirtschaftlichen Hochsch., Poznan, Pol.
SO   Albrecht-Thaer-Archiv (1967), 11(6), 563-81
     CODEN: ATHAAY; ISSN: 0002-4929
DT   Journal
LA   German
AB    A review concerned primarily with the production of rapeseed oil.
      Major goals are improvement of winter hardiness and reduction of
      erucic acid content.  Oils with high levels of erucic acid are
      also of interest, however, because the erucic acid can be split by
      ozonolysis to yield brassylic acid and pelarogonic acid, both
      having many industrial uses. Mustard oils must be eliminated, as
      they have an unpleasant taste and toxic properties.  78
      references.


L52  ANSWER 27 OF 66  HCAPLUS  COPYRIGHT 2005 ACS on STN
AN   1967:30129  HCAPLUS
DN   66:30129
TI   Hydro- and oleophobic fluorine compounds
AU   Rozycka, Danuta; Grobelny, Marian; Chmiel, Jadwiga
SO   Chemik (1966), 19(9), 311-14
     CODEN: CHGLAY; ISSN: 0009-2886
DT   Journal
LA   Polish
AB    A review article which shows that compds. containing C7H15 or,
      better, C9F19 radicals make paper, fibers, and leather hydro- and
      oleophobic.  Certain compds. are Cr complexes of carboxylic acid
      containing the above radicals.
```

```
L52  ANSWER 28 OF 66  HCAPLUS  COPYRIGHT 2005 ACS on STN
AN   1966:53081  HCAPLUS
DN   64:53081
OREF 64:9964f-g
TI   The fatty acid composition of cod liver oil
AU   Lambertsen, Georg; Braekkan, Olaf R.
CS   Govt. Vitamin Lab., Norwegian Fisheries Res. Inst., Bergen
SO   Fiskeridirektorat. Skrifter, Ser. Teknol. Undersoek (1965), 4(11),
1-14
DT   Journal
LA   English
AB    The fatty acid composition was determined by using group
      separation by thin-layer partition chromatography in conjunction
      with gas-liquid chromatography. Values are given for 41 acids as
      percentages of the sum varying between 0.1% and 20.6%.  These
      results have been compared with the results from 9 similar studies
      reported during the past 5 years. Mean values have been calculated
      for the 11 major fatty acids and coeffs. of variation are given.
      The dominant acid is oleic acid C18:1 (25%), followed by the five
      acids C16:0 (11%), C16:1 (9%), C20:1 (11%), C20:5 (9%), and C22:6
      (10%).  A short historical review is given, and the results of 2
      older different methods of analysis are compared with the present
      results.
```

```
L52  ANSWER 30 OF 66  HCAPLUS  COPYRIGHT 2005 ACS on STN
AN   1964:37982  HCAPLUS
DN   60:37982
OREF 60:6675c-f
TI   Physical chemistry of lubricant action in drawing
AU   Korbut, V. M.; Veiler, S. Ya.; Likhtman, V. I.; Rebinder, P. A.
SO   Fiz.-Khim. Zakonomernosti Deistviya Smazok pri Obrabotke Metal.
Davleniem,
     Akad. Nauk SSSR, Inst. Fiz. Khim. (1963) 5-30
DT   Journal
LA   Unavailable
AB    General relations pertaining to lubrication are discussed on the
      basis of an extensive review of exptl. data obtained by P. A.
      Rebinder, et al.  Emphasis is placed on lubrication in deformation
      of metals by drawing, with especially attention to Al.  A
      lubricant must be surface-active with respect to the metal; thus,
      octyl alc. is a much more effective lubricant for Al than octane.
      At temps. above the m.p. of substances solid at room temperature,
      nonpolar substances (paraffin wax) lose completely their capacity
      to lubricate, while polar substances (cetyl alc., stearic acid)
      become more effective as lubricants.  Freezing of nonpolar
      substances, e.g. dodecane, improved their effectiveness as
      lubricants in the deformation of Al by drawing; i.e., the force
      required to produce the same degree of deformation was reduced.
      Reduction of the temperature of transformer oil to -60° had the
      same effect.  Polyisobutylene was a good lubricant for Al.  For
      solns. of surfactants (octyl alc., pelargonic acid) in a surface-
      inactive substance (octane), the lubricating effect increased with
      the concentration of the surfactant.  It is concluded from the
      exptl. results that the forces required for deformation of the
```

metal and the shear resistance of the lubricating layer (either the layer of lubricant or that formed by interaction of the lubricant with the metal) fully characterize lubricant action. From the practical standpoint, lubricants based on kerosine emulsol (which do not produce spots on the surface and have a good scouring action) were suitable for the rolling of Al, but not for the drawing of Al wire. To improve their characteristics, especially with respect to reduction of the deformation, Ca or Al stearate was added. Cf. Vliyanie Aktivnykh Smazochno-Okhlazhdayushchikh Zhidkoster na Kackestvo Poverkhnosti pri Obrabotke Metallov Rezaniem i Davleniem (Moscow-Leningrad) Izd. Akad. Nauk SSSR, 1946.

L52 ANSWER 31 OF 66 HCAPLUS COPYRIGHT 2005 ACS on STN
AN 1961:127223 HCAPLUS
DN 55:127223
OREF 55:23939b
TI Petrolatum for drugs and cosmetics
AU Schindler, Hans
CS Sonneborn Chem. & Refining Corp., New York
SO Drug & Cosmetic Industry (1961), 89, 36-7,76,78-80,82
CODEN: DCINAQ; ISSN: 0012-6527
DT Journal
LA Unavailable
AB A historical review of the industry. 15 refs.

L52 ANSWER 32 OF 66 HCAPLUS COPYRIGHT 2005 ACS on STN
AN 1959:34736 HCAPLUS
DN 53:34736
OREF 53:6199a-i,6200a-e
TI Volatile constituents of black-rotted sweet potato and related substances
AU Kubota, Takashi
CS Osaka City Univ.
SO Tetrahedron (1958), 4, 68-86
CODEN: TETRAB; ISSN: 0040-4020
DT Journal
LA Unavailable
AB cf. C.A. 50, 293i. Four β-substituted furans, ipomeamarone (I), batatic acid (II), ipomeanine (III), and β-furancarboxylic acid (IV) were isolated from the volatile component of sweet potatoes infected by Ceratostomella fimbriata. The chemical constitutions of I, II, and III and of ngaione (V) and myoporon (VI), isolated from essential oil of the Myoporum species, were determined and the structural relations between I, V, and VI established. The infected part (120 kg.) finely sliced and extracted with Et2O, the extracted crude oil (1.3 kg.) shaken with aqueous NaHCO3, and the neutral oil (1.2 kg.) repeatedly fractionated at 0.01-0.001 mm. yielded 49 g. III, b0.001 69-95°, n22D 1.490-1.485, [α]D 10°, and 196 g. I, b0.001 100-3°, n22D 1.481-1.478, [α]D 22-28°. The crude III gave a small amount of palmitic acid on standing. The Et2O-washed NaHCO3 extract acidified with H2SO4, extracted with Et2O, and the crude acidic oil (VII) repeatedly fractionated gave a fraction, b. 90-115°, containing 0.5 g. trans-PhCH:CHCO2H, a

fraction, b. 115-20°, containing 0.8 g. II and an oil (furan ring), and a fraction of 1.0 g. IV (sublimed). VII contained PrCO2H and BuCO2H as shown by paper chromatography. Healthy potatoes gave neg. tests for furan compds. Repeated fractionation of I gave almost pure material, b0.001 103°, n15D 1.4827, d16 1.0423, [α]25D 28.07° (alc.); semicarbazone, m. 133-4°. I was neg. in Fehling and decolorized fuchsin tests, inactive to Ac2O, Bz2O, or (p-O2NC6H4CO)2O, consumed 2 moles Br in CCl4 with liberation of 2 moles HBr, gave a titration value of 1.45 with BzO2H, and was hydrogenated with 2 moles H. I added maleic anhydride, was oxidized with KMnO4 to give iso-BuCO2H, and gave a value of 1.85 in the Kuhn-Roth determination of C-Me group. Treatment of I with PhMgBr and dehydration of the carbinol followed by ozonolysis gave Me2CHCH2Bz. Ozonolysis of I and oxidative decomposition of the ozonide with CrO3 gave ipomolactone (VIII), C11H15O3, b0.001 108-12°, n9.5D 1.4610, and ipomeanic acid (IX), C12-H20O4, b0.001 108-10°, n10D 1.4533. VIII ring cleaved, esterified, and distilled gave Me anhydroipomate (X). X semicarbazone gave AcCH2CH2CO2Me and Me2CHCH2C(: NNHCONH2)CH: NNHCONH2. Catalytic reduction of X and saponification of the semicarbazone of the product gave Me2CHCH2C(: NNHCONH2)CH2 CHMeCH2CH2CO2H, identical with the compound synthesized from MeCHICH2CH2CO2Me and Me2CHCH2COCH2CO2Me. The formula assumed for VIII was confirmed by synthesis (cf. Matsuura, C.A. 48, 12071d). IX was assumed to have the :CHCO2H group in place of: CO in VIII and the assumption was verified by Wieland-Barbier decomposition of IX to VIII. Since I gave crimson, violet-red, and blood-red colorations with HCl, p-Me2NC6H4CHO, and SbCl3, the presence of a furan ring was predicted. Alder-Rickert degradation of I gave furan-3,4-dicarboxylic acid and established the structure of I (C.A. 47, 6395a), confirmed by synthesis from IV (C.A. 51, 3551i). Review of the synthetic route for I led to the conclusion that natural ±-I, obtained by ring cleavage of trans-I with Ac2O and KOAc followed by recyclization, is (±)-cis-I and that the side chain in natural (+)-I has also the cis configuration. II, C10H12O4, m. 88.5-9.5°, [α]D 17.5°, gave no Ac derivative and probably contains 1 C-Me group; 2,4-dinitrophenylhydrazone, m. 154.5-5.5°; semicarbazone, m. 177.5-8.5°; p-BrC6H4COCH2 ester, m. 94-5°. Ozonolysis of II gave HO2CCH2CH2CHMeCO2H, identical to a synthetic preparation II gave no Ehrlich reaction, no reaction for double bonds, and no adduct with maleic anhydride. However, reduction with LiAlH4 converted II into a substance pos. to these reactions and the lack of sensitivity of II was attributed to the stabilization of the furan ring by the α-CO group in the side chain. The assumed structure of II was proved by synthesis of (±)-II (cf. Naya, C.A. 52, 348h). III, C9H10O3, gave a bis(2,4-dinitrophenylhydrazone), m. 232-4°, but reacted abnormally with H2NNHCONH2 to give a dehydrated monosemicarbazone, C10H11N3O2, m. 215-16°. III adsorbed 2 moles H to form tetrahydroipomeanine (semicarbazone, m. 174-5°), gave a maleic anhydride adduct, m. 117-18°, was oxidized with KMnO4 to levulic acid, and ozonized to form levulic and formic acids. Accordingly III was assumed to have the structure α-(AcCH2CH2CO)C4H3O, confirmed by synthesis (C.A. 49, 10925h). I and V have similar phys. data with the exception of optical rotations, [α]D 85° and -66.2° resp. Ozonolysis of I and V gave IX, transformed to semicarbazones, m.

167°, [α]D -81° (alc.), and m. 171.2°, [α]D -40° (alc.)., both belonging to the cis system. The semicarbazones of I and V have identical infrared absorption curves and it was concluded that I and V are optical isomers [(+)-I, [α]D 28°; (-)-V, [α]D -25°]. It is possible that IX semicarbazone from V is partially racemized. The chief component of Myoporum bontioides was found by Kubota and Matsuura (C.A. 51, 16409a) to be VI, C15H22O3, b0.01 117-19°, n21D 1.4770, [α]D 0°, giving a pos. Ehrlich reaction and forming dimorphic 2,4- dinitrophenylhydrazones, red α-compound, m. 193°, [α]23D) -28.2°, and orange-red β-compound, turning reddish at 143-5°, m. 193°. Ozonolysis of VI gave dihydroanhydroipomic acid; semicarbazone, m. 139-41°. The assumed structure, α-(Me2CHCH2COCH2CHMeCH2CH2CO)C4H3O, was proved by synthesis (K. and M., loc. cit.). The infrared absorption bands at 3.20, 6.40, 6.62 μ were selected as characteristic of the furan ring and the values around these bands given by various furan compds. investigated by K., et al., are tabulated. I, V, and VI are normal sesquiterpenes with the chain end cyclized to a furan ring. I was formed by abnormal metabolism of starch probably by operation of the Krebs cycle. V and VI are considered to be the normal metabolic accumulation of the higher vegetable, Myopurum. The formation of (+)-I and (-)-V may offer a key to the elucidation of biol. reactions in the future. II, III, and IV are presumably formed by secondary oxidation of I in black-rotted sweet potatoes (or in Myoporum in the formation of IV).

L52 ANSWER 36 OF 66 CROPB COPYRIGHT 2005 THE THOMSON CORP on STN
AN 84-86338 CROPB I G
TI LITERATURE REFERENCES TO CHEMICAL CONTROL OF MOSQUITOES 1979-83.
AU SOLLERS RIEDEL H
LO WASHINGTON,D.C.,USA.
SO MOSQ.NEWS (44, NO.2, PT.1, 256-61, 1984)
LA English
DT Journal

L52 ANSWER 37 OF 66 CROPB COPYRIGHT 2005 THE THOMSON CORP on STN
AN 84-82141 CROPB I Q
TI LITERATURE REFERENCES TO MOSQUITOES AND MOSQUITO-BORNE DISEASES.
1983 -
PART IV.
AU SOLLERS RIEDEL H
LO WASHINGTON,D.C.,USA.
SO MOSQ.NEWS (43, NO.4, 511-27, 1983)
LA English
DT Journal

L52 ANSWER 38 OF 66 CROPU COPYRIGHT 2005 THE THOMSON CORP on STN
AN 2003-84892 CROPU J
TI Phytochemical based strategies for nematode control.
AU Chitwood D J
CS USDA-ARS
LO Beltsville, Md., USA
SO Annu.Rev.Phytopathol. (40, 221-49, 2002)

```
        CODEN: APPYAG
DT      Journal
LA      English
FA      AB; LA; CT
AB       Naturally occurring phytochemicals from various plants, algae and
         fungi with antagonistic activity towards plant-parasitic and
         other nematodes were reviewed in terms of their utilization in
         agriculture. Phytochemicals with nematotoxic activity included
         Sincocoin, alpha-terthienyl, allyl isothiocyanate, 2-phenylethyl
         isothiocyanate, dhurrin, manipueira linamarin, thiarubrine C,
         physostigmine, chelerythrine, sanguinarine, bocconine,
         monocrotaline, N-methylcytisine, anagyrine, matrine,
         sophocarpine, nicotine, cytisine, aloperine, colchicine,
         serpentine, myristic acid, palmitic acid, oleic acid, 2-
         undecylenic acid, methyl pelargonate, ethylene glycol
         pelargonate, 1-octanol, 1-triacontanol, triacontanyl
         tetracosanoate, linalool, eugenol, menthol, cineole, garaniol,
         citral, limonene, carvacrol, thymol, trans-anethole, (+)-carvone,
         citronellol, methyl chavicol and sophoramide.


L52     ANSWER 39 OF 66  CROPU  COPYRIGHT 2005 THE THOMSON CORP on STN
AN      2002-87738  CROPU   H S
TI      Strategies for the use of natural products for weed management.
AU      Duke S O; Rimando A M; Baerson S R; Scheffler B E; Ota E; Belz R
G
CS      USDA-ARS; Kubota; Univ.Hohenheim-Inst.Phytomed.
LO      University, Miss., USA, Ryugasaki, Jap.; Stuttgart, Ger.
SO      J.Pestic.Sci. (27, No. 3, 298-306, 2002)
        CODEN: NNGADV
DT      Journal
LA      English
FA      AB; LA; CT
AB       New strategies and technologies for exploiting natural products,
         including gramine, hordenine, BOA, DIBOA, DIMBOA, momilactone A,
         B and C, ineketone, oryzalexin A and C, sorgoleone,
         leptospermone, sulcotrione, 1,2-cineole, usnic acid (usnate),
         pelargonic acid ( pelargonate), cinmethylin and AAL-toxin, for
         weed management were reviewed in terms of crop allelopathy,
         including genetic manipulation, or herbicide development.
         Perlargonate is sold for weed control in turf. Triketone
         herbicides were derived from leptospermone, an allelochemical
         produced by Callistemon spp.  These compounds were phytotoxic by
         inhibition of hydroxyphenylpyruvate dioxygenase (HPPD).  Usnate
         and sorgoleone were also potent inhibitors of HPPD.  Cinmethylin
         is a close analog of 1,4-cineole which was a potent inhibitor of
         asparagine synthetase (AS).  Cinmethylin had no effects on AS in-
         vitro.


L52     ANSWER 40 OF 66  CROPU  COPYRIGHT 2005 THE THOMSON CORP on STN
AN      2002-85955  CROPU   H L
TI      Caltrans and roadside weed control.
AU      Shields L
LO      Sacramento, Cal., USA
SO      Proc.Calif.Weed Sci.Soc. (53 Meet., 56-59, 2001)
DT      Conference
```

```
LA    English
FA    AB; LA; CT
AB     Roadside weed control by the California Department of Transport
       (Caltrans) covers about 15,000 miles of highway and 230,000 miles
       of right-of-way.  In 1992, Caltrans completed an environmental
       impact report (EIR) on its vegetation control, including a risk
       assessment of chemical weed control methods, and reductions of
       50% and 80% in herbicide use were proposed for 2000 and 2012,
       resp.  Strategies used to reduce herbicide use by 50% included
       site-specific planning, improved spray equipment, increased
       manual controls, and herbicide alternatives (AquaHeat hot water
       sprays, corn gluten, steam heating, roofing foam, Weed-Ender
       fabric mulch), covering with organic mulches, burning, extra
       paving and improved mower design.  Bioherbicides, barriers,
       steam, cultivation, mechanical + chemical control, natural plant
       products and UV light are also being researched. (conference
       paper).


L52   ANSWER 41 OF 66  CROPU  COPYRIGHT 2005 THE THOMSON CORP on STN
AN    2002-84831  CROPU   P G
TI    Chemicals, timing, and environmental factors involved in thinner
efficacy
      on apple.
AU    Greene D W
CS    Univ.Massachusetts
LO    Amherst, Mass., USA
SO    Hortscience (37, No. 3, 477-81, 2002)
      CODEN: HJHSAR
DT    Conference
LA    English
FA    LA; CT
AB     A review of chemicals, timing, and environmental factors involved
       in thinner efficacy on apple, was presented.  Plant growth
       regulators mentioned included sodium dinitro-ortho-cresoate
       (DNOC; Elgetol), urea sulfate (Wilthin), endothal, pelargonate
       (MYX4801), ammonium thiosulfate, hydrogen cyanamide (Dormex),
       ethephon, naphthylacetamide, carbaryl (Sevin XLR Plus),
       benzyladenine (BA), and Accel (BA + GA4+7).  Times of application
       discussed were bloom, petal fall to 5 mm, 7 to 12 mm, 14 to 18
       mm, and 20 mm and larger. Environmental factors (the weather)
       before, during, and after application were discussed and included
       wind, rain, temperature, sunlight strength (i.e.  shading due to
       clouds), and frost. ((congerence paper) (No EX).


L52   ANSWER 42 OF 66  CROPU  COPYRIGHT 2005 THE THOMSON CORP on STN
AN    2002-84830  CROPU   P G
TI    Blossom thinning of pome and stone fruit.
AU    Fallahi E; Willemsen K M
CS    Univ.Idaho; Univ.Washington-State
LO    Parma, Idaho; Pullman, Wash., USA
SO    Hortscience (37, No. 3, 474-77, 2002)
      CODEN: HJHSAR
DT    Conference
LA    English
FA    LA; CT
```

```
AB     A review of blossom thinning in pome and stone fruit was
       presented.Experiments reviewed included peach trees (cv. Early
       Spur Rome) sprayed with post bloom thinner only (carbaryl (Sevin
       XLR Plus) at 0.094% + Regulaid at 0.094%), Endothall (endothal;
       0.125 or 0.1875%) + post bloom thinner, Thinex (pelargonate;
       0.3125%) + 0.375% Regulaid at or not at 40% bloom and at full
       bloom and post bloom thinner, Dormex (hydrogen cyanamide; 0.25%)
       + 0.125% Latron B-1956 at full bloom and post bloom thinner, in
       order to induce blossom thinning.  In further tests, apple (cvs.
       Delicious or Fuji) trees were sprayed with Endothall (0.125% +/-
       2 ammonium thiosulfate (ATS; 1%) applications, Endothall
       (0.1875%), or ATS (0.1875%) once or twice; and plum (cv. Friar)
       trees were sprayed with Wilthin (urea sulfate; 0.5, 0.75, or 1%)
       +/- Regulaid (0.125%). (conference paper).


L52    ANSWER 43 OF 66  CROPU  COPYRIGHT 2005 THE THOMSON CORP on STN
AN     2001-83056  CROPU   H L
TI     History, mechanisms, and strategies for prevention and management
of
       herbicide resistant weeds.
AU     Prather T S; DiTomaso J M; Holt J S
CS     Univ.California
LO     Parlier, Davis, Riverside, Cal., USA
SO     Proc.Calif.Weed Sci.Soc. (52 Meet., 155-63, 2000)
DT     Conference
LA     English
FA     AB; LA; CT
AB      History, mechanisms, and strategies for management of herbicide
        resistant weeds were reviewed.  Herbicides registered for use in
        California include diquat (Reward), paraquat (Gramoxone, Cyclone,
        Starfire), atrazine (Aatrex), cyanazine (Bladex), prometon
        (Oramitol), prometryn (Caparol), simazine (Princep), hexazinone
        (Velpar, Pronone), metribuzin (Sencor, Lexone), propanil (Stam,
        Stampede), bentazone (Basagran, Lescogran), desmedipham (Betanex,
        Betamix), phenmedipham (Betanal, Betamix, Spin-Aid), pyrazon
        (Pyramin), pyridate (Tough), bromacil (Hyvar), diuron (Karmex,
        Direx), linuron (Lorox), tebuthiuron (Spike), bromoxynil
        (Buctril, Moxy), imazapyr (Arsenal, Stalker, Chopper),
        imazethapyr (Pursuit), bensulfuron (Londax), chlorsulfuron
        (Telar, Glean), halosulfuron (Manage, Permit), nicosulfuron
        (Accent), rimsulfuron (Shade-Out, Matrix), sulfometuron (Oust).
        (conference paper).


L52    ANSWER 44 OF 66  CROPU  COPYRIGHT 2005 THE THOMSON CORP on STN
AN     2001-83022  CROPU   H
TI     Integrated plant management (IPM) in the landscape.
AU     Elmore C L
CS     Univ.California
LO     Davis, Cal., USA
SO     Proc.Calif.Weed Sci.Soc. (52 Meet., 11-13, 2000)
DT     Conference
LA     English
FA     AB; LA; CT
AB      Integrated plant management (IPM) in the landscape can include
        using plants for competition, mechanical cultivation, physical
```

```
         (hand pulling or hoeing), mulching, or pre and post herbicides,
         where the landscape can be defined as different planting areas
         such as turfgrass, bedding areas, flower plantings, shrub and
         ground cover plantings and tree basin areas. Pre herbicide for
         use in turfgrass or shrub beds include commercial formulations of
         oryzalin, benefin and trifluralin or oryzalin, isoxaben,
         pendimethalin or prodiamine.  Many pre herbicide can be applied
         around established plants to control weeds as they germinate
         without injuring the established plant and these herbicides
         generally have low water solubility and absorb tightly onto soil
         and organic particles. (conference paper).


L52     ANSWER 45 OF 66  CROPU  COPYRIGHT 2005 THE THOMSON CORP on STN
AN      2000-86765  CROPU   F H I Q C
TI      Biopesticides: a review of their action, applications and
        efficacy.
AU      Copping L G; Menn J J
CS      Univ.Pennsylvania-State
LO      Saffron Walden, U.K.; University Park, Pa., USA
SO      Pest Manage.Sci. (56, No. 8, 651-76, 2000) 1 Fig. 5 Tab. 106 Ref.
AV      LGC Consultants, Saxon Way, Saffron Walden, Essex CB11 4EG,
England.
DT      Conference
LA      English
FA      AB; LA; CT
AB       Biopesticides were reviewed with respect to their action,
         aplication and efficacy and included blasticidin S (Bla-S),
         kasugamycin, mildiomycin, natamycin, oxytetracycline
         (Mycoshield), polyoxin B (Polyoxin AL), polyoxorim (Kakengel and
         Polyoxin Z (zinc salts)), streptomycin (Agrimycin-17),
         validamycin (Validacin), avermectin (Dynamec), emamectin
         (Proclaim), milbemectin (Milbeknock), spinosad (spinosyn A +
         spinosyn D; Tracer), polynactins (Mitecidin (+ fenobucarb),
         Mitedown (+ fenbutatin oxide)), bilanafos sodium (Meiji
         Herbiace), azadirachtin (Trilogy), nicotine (Nico Soap),
         pelargonate, M-Pede, Scythe, De-Moss, Thinex, Neo-Fat, pyrethrins
         (Alfadex), rotenone (Chem Sect), Ryania extracts (Natur-Gro R-
         50), ryanodine, Sabadilla extracts, Veratrum extracts, Quassia,
         pipercide, affinin, pellitorine, BTG 504, BTG 505, pulegone,
         citronella oil, limonene and clove oil. (conference paper).


L52     ANSWER 46 OF 66  CROPU  COPYRIGHT 2005 THE THOMSON CORP on STN
AN      2000-85132  CROPU   H G L
TI      Herbicide options in the landscape.
AU      Wickham D
CS      Zeneca
LO      Cal., USA
SO      Proc.Calif.Weed Sci.Soc. (51 Meet., 9-10, 1999)
AV      No Reprint Address.
DT      Conference
LA      English
FA      AB; LA; CT
AB       In landscaped areas, herbicide choice for integrated weed control
         programs is affected by the proximity to the public, cost,
         product safety, location, toxicity and potential off-target
```

```
       damage.  Pre herbicides used include Ronstar (oxadiazon), Surflan
       (oryzalin), Pendulum (pendimethalin), Barricade (prodiamine),
       Gallery (isoxaben) and Snapshot (isoxaben + Treflan
       (trifluralin)).  Selective post herbicides include Envoy
       (clethodim) and Fusilade II (fluazifop) for grasses, Manage for
       sedges and Turflon (triclopyr), clopyralid, 2,4-D and dicamba for
       broadleaves.  Non-selective post herbicides include Roundup
       (glyphosate), Finale (glufosinate ammonium), Reward (diquat) and
       Scythe ( pelargonic acid).  Only Rodeo (glyphosate), Reward
       (diquat), copper and Sonar (fluridone) are registered for aquatic
       sites, where environmental concerns limit herbicide use.
       (conference paper).


L52   ANSWER 47 OF 66  CROPU  COPYRIGHT 2005 THE THOMSON CORP on STN
AN    2000-84891  CROPU   P
TI    Fruit thinning of peach trees.
AU    Costa G; Vizzotto G
CS    Univ.Bologna; Univ.Udine
LO    Bologna; Udine, It.
SO    Plant Growth Regul. (31, No. 1-2, 113-19, 2000) 1 Fig. 6 Tab. 74
Ref.
      CODEN: PGRED3
AV    Departimento di Colture Arboree, University of Bologna, Via
Filippo Re 6,
      40126 Bologna, Italy.
DT    Journal
LA    English
FA    LA; CT
AB     The importance of fruit thinning in peach trees was reviewed with
       special reference to treatment scheduling.  Thinning time is
       critical to achieve desired results.  Manual thinning is usually
       carried out towards the end of fruit growth stage II (pit
       hardening) or the beginning of stage III. There are several ways
       of reducing fruit/flower number by applying thinning chemicals at
       specific phenological stages: flower bud differentiation, fall
       and dormancy and bloom.  Thinning chemicals which have been
       applied include GA3, Ethrel (ethephon), hydrogen cyanamide,
       endothal, X-77, D-88, ammonium thiosulfate, 3-CPA (cloprop
       amide), CGA, orthonil, morphactins, NAA, urea, thiourea,
       armothin, terbacil, DNOC, NAA amide (naphthylacetamide), Thinex
       (pelargonate), PP333 (paclobutrazol) and Sevin (carbaryl).  Also
       mentioned are studies involving apple and nectarine. (No EX).


L52   ANSWER 48 OF 66  CROPU  COPYRIGHT 2005 THE THOMSON CORP on STN
AN    2000-84889  CROPU   F G C L
TI    Developments in the chemical thinning of apple and pear.
AU    Wertheim S J
LO    Wilhelminadorp, Neth.
SO    Plant Growth Regul. (31, No. 1-2, 85-100, 2000) 2 Fig. 6 Tab. 164
Ref.
      CODEN: PGRED3
AV    Fruit Research Station, 4475 AN Wilhelminadorp, The Netherlands.
DT    Journal
LA    English
FA    AB; LA; CT
```

AB   A review of past and present experiments of chemical flower and fruit thinners of apple and pear was presented. Chemicals mentioned were ethephon, DNOC, benzyladenine, NAA, NAA amide (naphthylacetamide), carbaryl (Sevin XLR), pelargonic acid, Wilthin (urea sulfate), endothal, MCPB-ethyl, NSK-905, paclobutrazol, hydrogen cyanamide (Dormex), ammonium thiosulfate, urea, calcium nitrate, NAA imide, ethyl NAA, NAA anhydride, methyl NAA, methyl NAA amide, fenclopyr (forchlorfenuron), thidiazuron and Promalin (GA4 + GA7). In addition, the effect of thinner combinations, sequential sprays and application technique on the efficacy of the chemicals was assessed. Chemical thinning practices give quite unpredictable results, partly caused by weather, air humidity and tree factors.

L52   ANSWER 49 OF 66 CROPU COPYRIGHT 2005 THE THOMSON CORP on STN
AN   2000-84882 CROPU   P G L
TI   The history of fruit thinning.
AU   Dennis F G Jr
CS   Univ.Michigan-State
LO   East Lansing, Mich., USA
SO   Plant Growth Regul. (31, No. 1-2, 1-16, 2000) 3 Tab. 159 Ref.
        CODEN: PGRED3
AV   Department of Horticulture, Michigan State University, East
Lansing, MI
        48824-1325, U.S.A.
DT   Journal
LA   English
FA   AB; LA; CT
AB   The history of fruit thinning was reviewed with reference to mechanical removal such as hand-thinning, and chemical thinning. Chemical thinning methods include the use of caustic sprays such as iron sulfate, copper sulfate, sodium nitrate, zinc sulfate, DNOC (Elgetol), sulfcarbamide (sulfanilylurea), pelargonic acid, endothal, ammonium nitrate, ammonium thiosulfate, hydrogen cyanamide, soap, waterglass (sodium silicate), mineral oils and rapeseed oil; plant growth regulators such as NAA, NAA amide (naphthylacetamide), ethephon, benzyladenine, Promalin (GA4 + GA7), Accel (BA + GA4 + GA7), carbaryl (Sevin XLR), CPPU (forchlorfenuron) and thidiazuron; insecticidal carbamates such as oxamyl (Vydate 2L), photosynthesis inhibitors such as terbacil, and the use of combinations of chemicals, multiple applications and surfactants (e.g. Tween 20).

L52   ANSWER 50 OF 66 CROPU COPYRIGHT 2005 THE THOMSON CORP on STN
AN   2000-82077 CROPU   P G C
TI   Chemical thinning of deciduous fruit trees.
AU   Wertheim S J
LO   Wilhelminadorp, Neth.
SO   Acta Hort. (463, 445-62, 1998) 1 Tab. 189 Ref.
AV   Research Station for Fruit Growing, 4475 AN Wilheminadorp, The
        Netherlands.
DT   Conference
LA   English
FA   AB; LA; CT

```
AB     The use of chemical thinners on deciduous fruit trees (peach,
       apple, pear, plum and prune) was reviewed with reference to known
       and new thinners, single, combined and sequential applications,
       and application techniques.  Known flower thinners include DNOC,
       ethephon and sulfur compounds, while new compounds are
       pelargonate (Thinex), urea sulfate (Wilthin), endothallate, MCPB-
       ethyl, NSK-905, paclobutrazol, Armothin, ammonium thiosulfate,
       urea and calcium-nitrate.  Fruit thinners include NAA, NAA amide,
       carbaryl (Sevin XLR, Sevin SL, Sevin 85), ethephon, fenclopyr
       (forchlorfenuron), thidiazuron, benzyladenine and ethylchlozate.
       The efficacy of combinations of NAA amide + ethephon, carbaryl +
       thiram, carbaryl + NAA, carbaryl + NAA amide, BA + NAA, carbaryl
       + BA and BA + GAs (Promalin) was described. (conference paper).


L52    ANSWER 51 OF 66  CROPU  COPYRIGHT 2005 THE THOMSON CORP on STN
AN     2000-80960  CROPU   H G
TI     Non-spray methods to control invasive weeds in urban areas.
AU     Ward B G; Henzell R F; Holland P T; Spiers A G
CS     Hort.+Food-Res.Inst.New-Zealand
LO     Hamilton; Palmerston North, N.Z.
SO     Proc.N.Z.Plant Prot.Conf. (52, 1-5, 1999) 18 Ref.
       CODEN: PNZCEJ
AV     The Horticulture and Food Research Institute of New Zealand
Limited,
       Ruakura Research Centre, Private Bag 3123, Hamilton, New Zealand.
DT     Conference
LA     English
FA     AB; LA; CT
AB      The control of invasive introduced weeds in highly populated
        urban areas on wetlands, roadside berms, hilly terrain, reserves
        and bush remnants, is reviewed.  Public concern about spraying
        has led to the introduction of alternative techniques, including
        use of herbicidal gels (e.g. glyphosate) applied by pruning
        equipment, roller (Weedball) application of gels onto crushed
        plants, injection of gels or solutions into rhizomes, bulbs,
        corms or fibrous tissue, pressure injection of herbicide
        solutions or pathogens (e.g. Trametes versicolor, Chondrostereum
        (Stereum) purpureum) into tree trunks and cut-stump applications
        for larger trees.  Other possible strategies include mechanical
        or flame weeding methods, mulching and use of herbicides from
        natural sources, such as Greenscape (fatty acids), Organic
        Interceptor (pine-oil based) and Scythe (pelargonic acid).
        (conference paper).



L52    ANSWER 53 OF 66  CROPU  COPYRIGHT 2005 THE THOMSON CORP on STN
AN     1985-82803  CROPU   Q
TI     Pheromones and Other Semiochemicals of the Acari.
AU     Sonenshine D E
LO     Norfolk, Va., USA
SO     Annu.Rev.Entomol. (30, 1-28, 1985) 5 Fig. 3 Tab. 94 Ref.
       CODEN: ARENAA
AV     Department of Biological Sciences, Old Dominion University,
Norfolk, Va.
```

```
      23508, U.S.A.
DT    Journal
LA    English
FA    AB; LA; CT
AB     Semiochemicals of Acari are reviewed; topics covered are; alarm,
       assembly, aggregation/attachment and sex pheromones (SPs),
       structure of pheromone glands and their regulation, pheromone
       perception and mate-finding processes, and possible practical
       uses of pheromones in control of Acari. Pheromones identified
       include; Neryl formate and citral (Tyrophagus spp.), farnesol,
       nerolidol and geraniol (Phytoseiidae), citranellol (Tetranychus
       urticae), methyl salicylate, perlargonic acid and O-nitrophenol
       (Amblyomma variegatum), 2,6-dichlorophenol (2,6-DCP, Dermacentor
       variabilis and D. andersoni), phenol and p-cresol (Rhipicephali).


L52   ANSWER 54 OF 66  CROPU  COPYRIGHT 2005 THE THOMSON CORP on STN
AN    1985-81425  CROPU   Q I P H F
TI    Chemicals From the Glands of Ants.
AU    Attygalle A B; Morgan E D
LO    Keele, U.K.
SO    Chem.Soc.Rev. (13, No. 3, 245-78, 1984) 3 Tab. 226 Ref
      CODEN: CSRVBR
AV    Department of Chemistry, University of Keele, Staffordshire ST5
5BG, U.K.
      (E.D.M.).
DT    Journal
LA    English
FA    AB; LA; CT
AB     The occurrence of chemicals in exocrine glands of ants
       (Formicidae) was reviewed.  Topics mentioned included
       biosynthesis and activity of the compounds.  Classes of compound
       mentioned included alkaloids, monoterpene hydrocarbons, aliphatic
       hydrocarbons, lactones, benzenoid compounds, oxygenated
       hydrocarbons, saturated and unsaturated fatty acids.


L52   ANSWER 55 OF 66  FROSTI  COPYRIGHT 2005 LFRA on STN
AN    121066   FROSTI
TI    Fatty acids, monoglycerides and sucrose esters as anticaries
agents.
      Review.
AU    Schemmel R.A.; Kabara J.J.
SO    The pharmacological effect of lipids 2, edited by J.J. Kabara.
Champaign:
      AOCS,   51-8 (39 ref. En)., 1985
DT    Book Article



L52  ANSWER 58 OF 66  EMBASE  COPYRIGHT 2005 ELSEVIER INC. ALL RIGHTS
RESERVED.
     on STN
AN   2003309291  EMBASE
TI   Lipids of the hexane extract from the roots of medicinal
Boraginaceous
     species.
```

```
AU   Papageorgiou V.P.; Assimopoulou A.N.
CS   V.P. Papageorgiou, Organic Chemistry Laboratory, School of
Chemical
     Engineering, Aristotle University of Thessaloniki, 54124
Thessaloniki,
     Greece. vaspap@eng.auth.gr
SO   Phytochemical Analysis, (2003) 14/4 (251-258).
     Refs: 47
     ISSN: 0958-0344  CODEN: PHANEL
CY   United Kingdom
DT   Journal; General Review
FS   029     Clinical Biochemistry
     037     Drug Literature Index
LA   English
SL   English
AB    The chemical compositions of hexane extracts of the lipid fraction
      of the roots of the medicinal Boraginaceous species Alkanna
      tinctoria, Onosma heterophylla, Macrotomia densiflora and Onosma
      hispidium are presented and their phytochemical relevance
      evaluated. The predominating fatty acids in all of the root lipids
      were stearic, palmitic, oleic, linoleic and γ-linolenic acids,
      while the latter and stearidonic acid predominated in the seeds
      and leaves of various Boraginaceous species. The indigenous
      presence of methyl, ethyl and isopropyl esters of fatty acids,
      reported for the first time in the roots of higher plants, is
      considered to be of particular importance in the biosynthesis of
      fatty substances. The results suggest the use of fatty acids as
      chemotaxonomic markers for Boraginaceous species and the
      utilisation of Boraginaceous species as new commercial sources for
      fatty acids with valuable medicinal and nutritional properties.
      Copyright .COPYRGT. 2003 John Wiley & Sons, Ltd.




L52  ANSWER 65 OF 66  EMBASE  COPYRIGHT 2005 ELSEVIER INC. ALL RIGHTS
RESERVED.
     on STN
AN   79087576  EMBASE
DN   1979087576
TI   Monographs on fragrance raw materials. Part 2.
AU   Opdyke D.L.J.
CS   Res. Inst. Fragrance Mater., Inc., Englewood Cliffs, N.J. 07632,
United
     States
SO   Food and Cosmetics Toxicology, (1978) 16/SUPPL. 1 (731-791).
     CODEN: FCTXAV
CY   United Kingdom
DT   Journal
FS   037     Drug Literature Index
LA   English

L52  ANSWER 66 OF 66  EMBASE  COPYRIGHT 2005 ELSEVIER INC. ALL RIGHTS
RESERVED.
     on STN
AN   79078405  EMBASE
```

```
DN    1979078405
TI    Monographs on fragrance raw materials. Part 3.
AU    Opdyke D.L.J.
CS    Res. Inst. Fragrance Mater., Inc., Englewood Cliffs, N.J. 07632,
United
      States
SO    Food and Cosmetics Toxicology, (1978) 16/SUPPL. 1 (793-883).
      CODEN: FCTXAV
CY    United Kingdom
DT    Journal
FS    037      Drug Literature Index
LA    English
```

DEGRADATION OF FATTY ACIDS IN LAWN SOIL

by

V. Mozol and W.W. Nijholt

Introduction

Fatty acids have their origin in land and marine animal fats, vegetable seed oils and organic synthesis (Pryde, 1979) and hold an essential part of our daily living.

This study deals with the following three fatty acids that have shown herbicidal, fungicidal and cryptocydal activity and may be applied in emulsified form or as their potassium salts:

1. nonanoic (pelargonic) acid - $C_9H_{18}O_2$
2. decanoic (capric) acid - $C_{10}H_{20}O_2$
3. dodecanoic (lauric) acid - $C_{12}H_{24}O_2$

The literature shows many references related to the natural occurrence pf these fatty acids such as; Rothman (1949), who found that the sebaceous glands of the scalp secrete a sebum containing saturated fatty acids of chain length C_6 to C_{22}, including C_9, C_{10} and C_{12}; Nicolaides (1974) reported that human skin contains fatty acids from C_{10} and C_{12} to C_{30}; Li (1978) found that lauric acid occurs naturally in forest soils and is a major component of the soil lipids in mixed alder-conifer stands. Coconut, a common foodstuff, contains high concentrations of lauric acid and significant amounts of capric acid; Weitkamp *et al.* (1947) reported that saturated fatty acids, including C_9, C_{10} and C_{12} occur naturally in human hair. Pelargonic acid occurs as an ester of pelargonium, (Redtenbacher 1846), and is produced commercially by organic synthesis from oleic acid, (Sprecher 1971).

Decomposition of fatty acids in the environment has been studied extensively from aspects such as physiochemical degradation, (Stumpf 1965) and microbiological degradation under aerobic or anaerobic conditions, (Moncawi *et al.* 1981, Braids and Muller 1975, Mukherjee 1950).

Further references list microbes, fungi and plant enzymes as devices for lipid degradation in soils, (Nelson and Tisdale 1975, Ivler, Wolfe and Rittenberg 1955, Krause and Lang 1965, Stern, Ordal and Halvorson 1954, Waksman, Tenny and Stevens 1928). The purpose of this study is to examine the degradation of these fatty acids after application to lawn soil.

.../2

Materials and Methods

Recovery

For degradation studies, soil, collected from below lawn turf and sifted through 2 mm wire mesh was used with one portion sterilized at 125°C at 25 psi for 20 minutes. To monitor moisture conditions during the experiment, dry weight determinations were made at intervals over a 3 week period. Recovery of fatty acids from soils was accomplished by leaching, extraction and G.L.C. analysis both from untreated and treated with a known amount of a fatty acid salt mixture, based on recommended application rates to a surface area. For this experiment, 40 gm of a 2% solution to 600 gm soil was selected. A salt mixture was used to achieve wetting and homogeneous mixing and with the understanding that the salt mixture breaks down into its equivalent fatty acid complement.

Leaching

For the leaching procedure, 20 gm of soil sample was placed on a course filter paper in a 100 ml Buchner funnel. Using vacuum suction, 200 ml of distilled water was washed over the soil and the leachate placed in a 500 ml separatory funnel (containing 10 ml $CHCL_3$) for extraction. Two consecutive amounts of 10ml, $CHCL_3$ were followed by two amounts of 10 ml CH_3OH and mixed with the soil for 2 minutes, then leached through and placed into another 250 ml separatory funnel (containing 100 ml distilled water) for extraction.

Extraction

The contents of the separatory funnels were acidified with one drop conc. H_2SO_4 and after shaking left to separate. Any cloudiness or emulsion was removed by direct addition of 2-4 ml CH_3OH to the $CHCL_3$ layer. The $CHCL_3$ layer was drawn off and two additional extractions with 10 ml $CHCL_3$ each were performed. To the combined extracts was added 5 ml of 0.5% $C_{11:1}$ (10-undecanoic acid) in $CHCL_3$, as an internal standard.

Methylation

Methylation of the sample aliquot was based on the method by Metcalfe (1966).

The $CHCL_3$ was evaporated and the residue transferred with petroleum ether to a 10 ml screw cap vial and the ether evaporated to dryness. After addition of 0.5 ml BF_3/CH_3OH (14%)

.../3

the vial was tightly sealed and placed in boiling water for two minutes. Upon cooling 1 ml of hexane and 0.5 ml of distilled water were added. The vial contents were shaken for 20 seconds and centrifuged. The top (hexane) layer was removed and used for GLC analysis.

G.L.C. Analysis

Instrument: HP 5880 A. Gas Chromatograph.
Parameters:

Oven Temperature Initial time:	0 min.
Initial value:	140°C
Final time:	2 min.
Final value:	180°C
Program rate:	20°C/min.
Column:	25 m OV101 HP capillary
Amount injected:	2 ul
Split ratio:	1/50

All samples were run in duplicate with 3 runs per replicate and the results calculated against the internal standard in comparison with a calibration standard.

Results and Discussion

Moisture tests indicated that the humidity of the soil environments was kept reasonably constant (Table 1).

Table 1: Moisture analysis of soil environments.

Time	Sample Number 1)			
	1	2	3	4
Start	13.7 2)	11.9	19.1	18.0
Day 7	13.2	10.0	18.1	16.2
Day 14	13.0	10.3	18.6	16.3
Day 21	13.4	10.1	18.1	16.0

1) 1. unsterilized soil, 2. sterilized soil, 3. unsterilized soil + 2% fatty acid salts, 4. unsterilized soil + 2% fatty acid salts.
2) % moisture based on differential dry weight measurement.

.../6

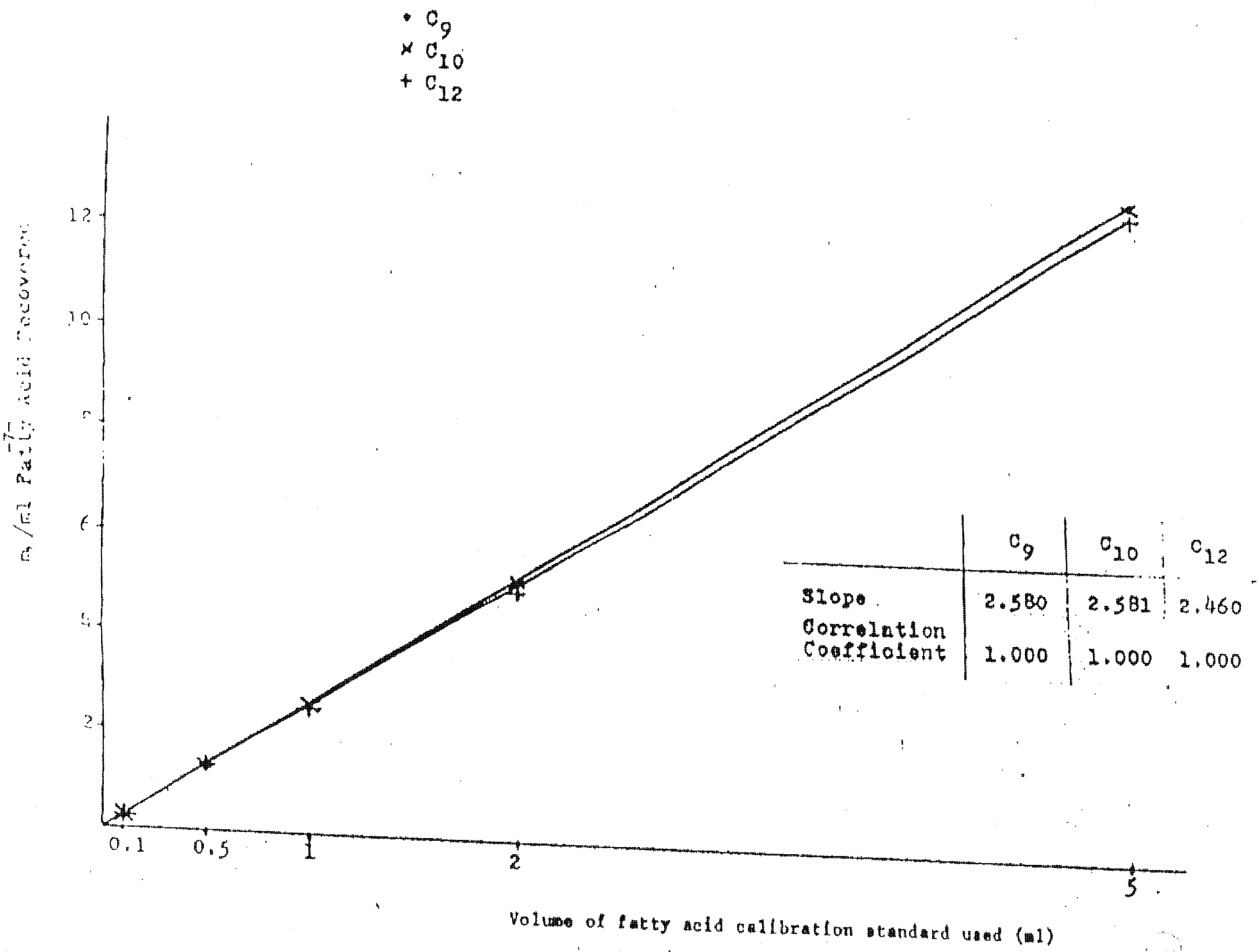
The linearity of the procedure was determined for the calibration standard and the fatty acid salt solution and found to be very good. (Table 2 and Figs. 1 and 2). The precision for both the calibration standard and the fatty acid moisture was within ± 3%, the accuracy was within ± 2%.

The data given in Table 3 and Fig. 3 for total recovery of C9, C10 and C12 showed that the natural fatty acid content of sterilized and unsterilized soils was very low compared to the fatty acid content of the treated soils. For both soils the major portion of the applied fatty acids (± 60%) complexed with the soil. Within 2 days the fatty acid content in the treated, unsterilized soil drastically decreased, and by day 10 the fatty acid content had dropped to almost its original level. The fatty acid content of the sterile soil remained high during this time, implying that the fatty acid degradation in the unsterilized soil was of a biological nature. This conclusion is supported by the literature referred to previously. After 20 days the fatty acid content in the treated steril soil decreased as well and indicated re-establishment of microbiological activity in this soil. The data revealed that the non-complexed fatty acids, from the water leach, degraded faster than the complexed acids. The order of degradation appears to be C_9, C_{10}, followed by C_{12}, though the difference in rates were very slight.

Conclusion

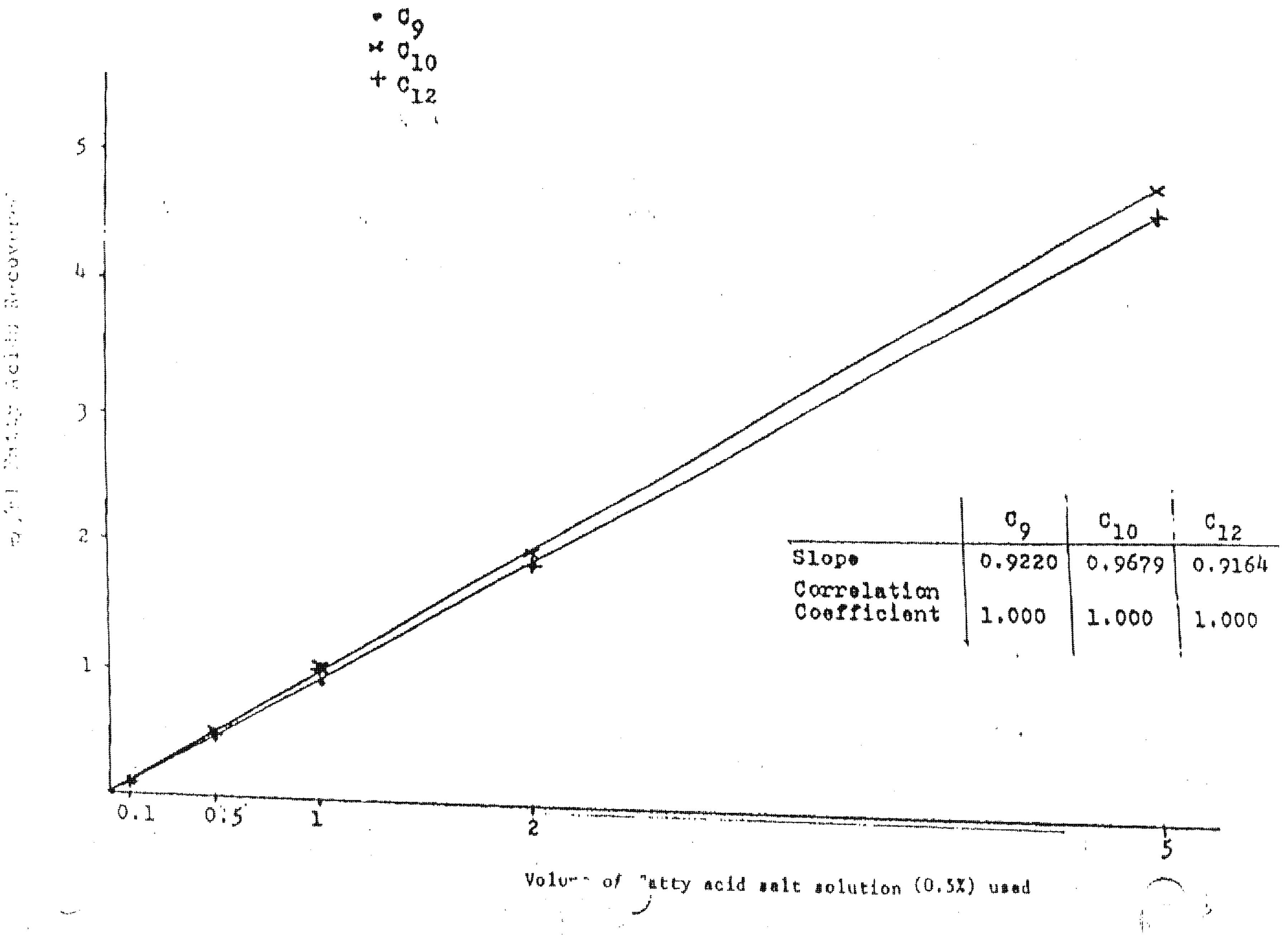
Practically all of the fatty acids applied to natural soil degraded within a period of 2 days and this degradation appears to be of a microbiological nature.

Fig 11 - GLC Linearity of fatty acid calibration standard
Volume (ml) of fatty acid calibration standard used vs mg/ml fatty acid recovered



	C_9	C_{10}	C_{12}
Slope	2.580	2.581	2.460
Correlation Coefficient	1.000	1.000	1.000

Fig. 2: Linearity of fatty acid salt solution (0.5%)
Volume of 0.5% solution used vs mg/ml fatty acids recovered



	C_9	C_{10}	C_{12}
Slope	0.9220	0.9679	0.9164
Correlation Coefficient	1.000	1.000	1.000

Table 2: Linearity of G.L.C. data for calibration standard and 5% concentration of fatty acid salts using amounts of 0.1-5.0 ml.

Sample mg/ml Fatty Acid recovered ($\bar{x}_n \pm \sigma_n$) 1)

Sample Volume Used (ml)	0.1			0.5			0.1			2.0			5.0		
Fatty Acids	C_9	C_{10}	C_{12}	C_9	C_{10}	C_{12}	C_9	C_{10}	C_{12}	C_9	C_{10}	C_{12}	C_9	C_{10}	C_{12}
Sample															
Cal. Std. Std. σ	0.261 ±0.002	0.265 ±0.002	0.259 ±0.003	1.249 ±0.029	1.284 ±0.015	1.264 ±0.016	2.528 ±0.032	2.325 ±0.008	2.501 ±0.009	5.080 ±0.045	5.108 ±0.024	4.952 ±0.024	12.884 ±0.355	12.899 ±0.170	12.325 ±0.128
FAS (0.5%) Std. σ	0.086 ±0.001	0.092 ±0.001	0.090 ±0.002	0.453 ±0.002	0.487 ±0.004	0.465 ±0.003	0.907 ±0.010	1.010 ±0.012	1.041 ±0.020	1.841 ±0.021	1.930 ±0.017	1.842 ±0.019	4.601 ±0.030	4.850 ±0.028	4.610 ±0.022

1) $\bar{x}_n$ mean of two replicates of three G.L.C. runs each.
σ_n = Standard Deviation

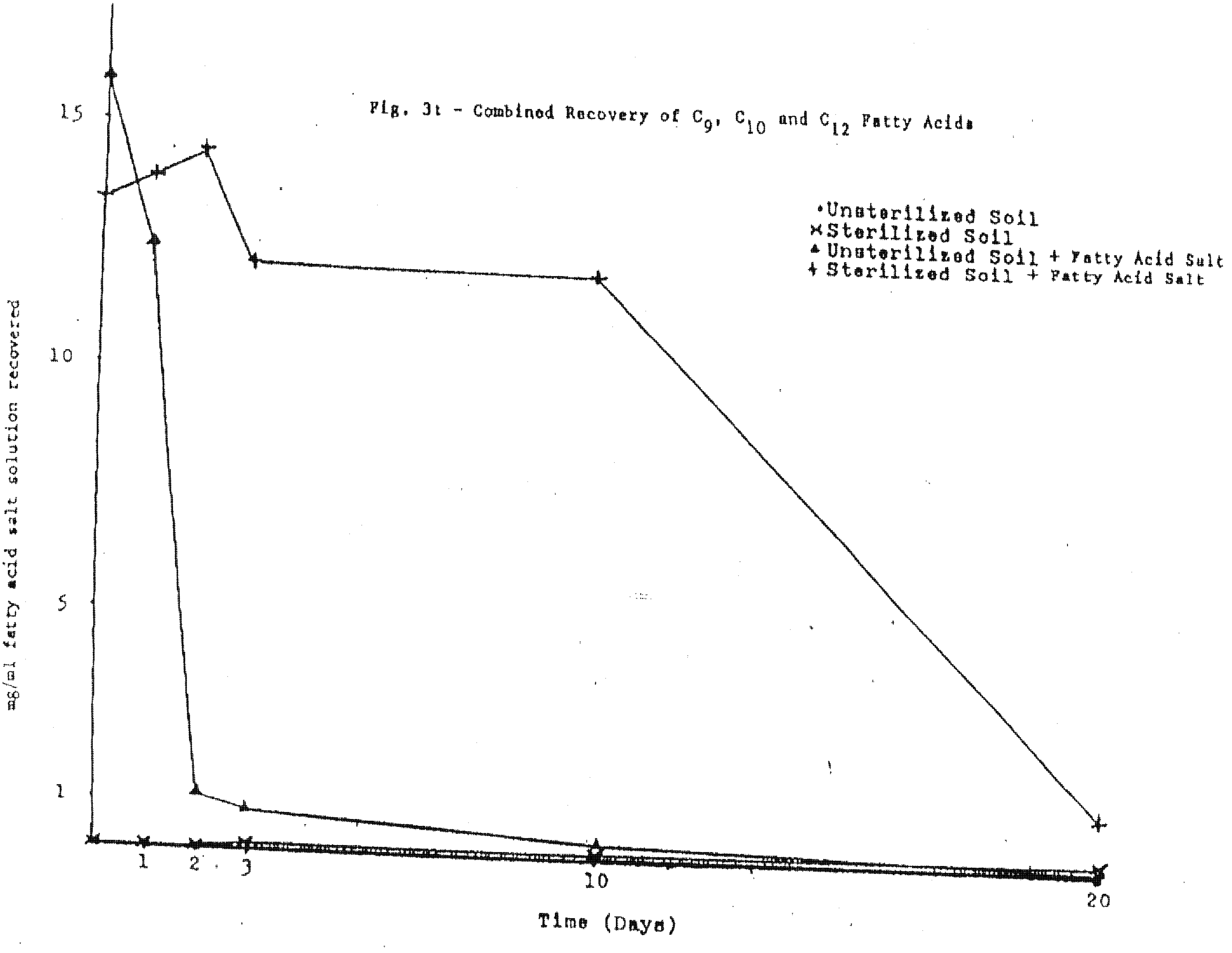


Fig. 3: - Combined Recovery of C_9, C_{10} and C_{12} Fatty Acids

Table 3: Recovery of fatty acid from soil samples with and without treatment with fatty acid salts, after water leaching and $CHCl_3$ extraction.

		Amount of Fatty Acids Found (mg/ml)															
Soil Environments 1)		1.				2.				3.				4.			
TIME	EXTRACT	C_9	C_{10}	C_{12}	TOTAL	C_9	C_{10}	C_{12}	TOTAL	C_9	C_{10}	C_{12}	TOTAL	C_9	C_{10}	C_{12}	TOTAL
Start	H_2O	-	0.004	0.005	0.009	-	-	0.008	0.008	4.982	5.241	2.403	12.626	3.630	3.590	1.769	8.989
	$CHCl_3$	0.007	0.010	0.020	0.037	0.013	0.016	0.016	0.045	0.189	0.587	2.553	3.329	0.506	1.236	2.735	4.477
	Combined	0.007	0.014	0.025	0.048	0.013	0.016	0.024	0.053	5.171	5.828	4.956	15.955	4.136	4.826	4.504	13.466
Day 1	H_2O	-	0.004	0.005	0.009	-	-	0.008	0.008	1.455	2.850	2.011	6.316	3.923	4.172	2.024	10.119
	$CHCl_3$	0.008	0.009	0.014	0.031	0.013	0.015	0.019	0.047	1.468	2.848	2.037	6.353	0.516	1.049	2.252	3.812
	Combined	0.008	0.013	0.019	0.040	0.013	0.015	0.027	0.055	2.923	5.698	4.048	12.669	4.439	5.216	4.275	13.931
Day 2	H_2O	-	0.004	0.005	0.009	-	0.005	0.011	0.016	0.109	0.231	0.229	0.569	3.818	3.910	1.600	9.328
	$CHCl_3$	-	0.029	0.036	0.065	0.007	0.018	0.024	0.049	0.054	0.139	0.346	0.539	0.641	1.443	3.086	5.170
	Combined	-	0.033	0.041	0.074	0.007	0.023	0.035	0.065	0.163	0.370	0.575	1.108	4.459	5.353	4.686	14.498
Day 3	H_2O	-	-	0.010	0.010	-	0.004	0.010	0.014	-	0.043	0.201	0.244	3.240	3.797	1.799	8.836
	$CHCl_3$	-	0.003	0.015	0.018	0.023	0.038	0.046	0.107	-	0.103	0.541	0.644	0.301	1.091	1.905	3.425
	Combined	-	0.005	0.023	0.028	0.023	0.042	0.056	0.121	-	0.146	0.742	0.888	3.741	4.888	3.704	12.261
Day 10	H_2O	-	-	0.010	0.010	-	0.004	0.008	0.012	-	0.007	0.024	0.031	2.954	3.642	1.777	8.368
	$CHCl_3$	-	-	0.025	0.025	0.008	0.047	0.050	0.111	0.009	0.101	0.159	0.269	0.456	0.984	2.321	3.769
	Combined	-	-	0.035	0.035	0.008	0.051	0.058	0.123	0.009	0.108	0.183	0.300	3.410	4.626	4.098	12.137
Day 20	H_2O	-	0.004	0.006	0.010	-	0.004	0.010	0.014	-	0.007	0.27	0.034	0.021	0.051	0.099	0.171
	$CHCl_3$	-	0.005	0.014	0.019	0.010	0.050	0.044	0.104	-	0.008	0.025	0.033	0.045	0.143	0.799	0.987
	Combined	-	0.009	0.020	0.029	0.010	0.054	0.054	0.118	-	0.015	0.052	0.067	0.066	0.174	0.898	1.158

1) Soil Environments:

1. unsterilized soil
2. sterilized soil
3. unsterilized soil with fatty acid salt solution added
4. sterilized soil with fatty acid salt solution added.

FATE OF CAPRIC AND PELARGONIC FATTY ACIDS IN SOIL

by V. Mozol, W.W. Nijholt, D. McHarg

INTRODUCTION

This study deals with the following two fatty acids which possess herbicidal properties:

Nonanoic (pelargonic) acid - $C_9H_{18}O_2$
Decanoic (capric) acid - $C_{10}H_{20}O_2$

These fatty acids occur naturally in the environment and within food chains for aquatic and terrestrial organisms (Berrie, 1979; House, 1967; Nicolaides, 1974; Rothman, 1949; Weikamp, 1947). Capric and pelargonic acids are synthesized biologically and obtained commercially by recovery from Lythaceae seed oil to yield capric acid (Merck Index, 1976), and by ozonolysis of oleic acid to yield pelargonic acid (Merck Index, 1976; Sprecher 1971). Degradation of fatty acids by physiochemical and microbiological pathways are well documented (Berrie, 1979; Braids, 1975; Guthrie, 1975; Stumpf, 1965). Fungi, microbes and plant enzymes metabolize fatty acids in soil environments (Braids, 1975; Ivler, 1955; Krause, 1965; Lewis, 1967; Moucawi, 1981; Mukherjee, 1952; Nelson, 1975; Stern, 1954; Walkinshaw, 1968; Waksman, 1928).

Materials and Methods

Recovery

For degradation studies, soil, collected from below lawn turf (0-10 cm) and sifted through 2 mm wire mesh was used with one portion sterilized at 125°C at 25 psi for 20 minutes. pH of the lawn soil was 6.10 and is classified as sandy loam. To monitor moisture conditions during the experiment, dry weight determinations were made at intervals over a 3 week period. Recovery of fatty acids from soils was accomplished by leaching, extraction and G.L.C. analysis both from untreated and treated with a known amount of fatty acid salt mixture, based on recommended application rates to a surface area. For this experiment, 40 gm of a 2% solution to 600 gm soil was selected. A salt mixture was used to achieve wetting and homogeneous mixing and with the understanding that the salt mixture breaks down into its equivalent fatty acid complement.

Leaching

For the leaching procedure, 20 gm of soil sample was placed on a coarse filter paper in a 100 ml Buchner funnel. Using vacuum suction, 200 ml of distilled water was washed over the soil and the leachate placed in a 500 ml separatory funnel (containing 10 ml $CHCl_3$) for extraction. Two consective amounts of 10 ml $CHCL_3$

.../2

were followed by 2 amounts of 10 ml CH_3OH and mixed with the soil for 2 minutes, then leached through and placed into another 250 ml separatory funnel (containing 100 ml distilled water) for extraction.

Extraction

The contents of the separatory funnels were acidified with one drop conc. H_2SO_4 and after shaking left to separate. Any cloudiness or emulsion was removed by direct addition of 2-4 ml CH_3OH to the $CHCl_3$ layer. The $CHCl_3$ layer was drawn off and two additional extractions with 10 ml $CHCl_3$ each were performed. To the combined extracts was added 5 ml of 0.5% $C_{11:1}$ (10-undecanoic acid) in $CHCl_3$, as an internal standard.

Methylation

Methylation of the sample aliquot was based on the method by Metcalfe (1966).

The $CHCl_3$ was evaporated and the residue transferred with petroleum ether to a 10 ml screw cap vial and the ether evaporated to dryness. After addition of 0.5 ml BF_3/CH_3OH (14%) the vial was tightly sealed and placed in boiling water for two minutes. Upon cooling 1 ml of hexane and 0.5 ml of distilled water were added. The vial contents were shaken for 20 seconds and centrifuged. The top (hexane) layer was removed and used for GLC analysis.

G.L.C. Analysis

Instrument: HP 5880 A. Gas Chromatograph.

Parameters:	Oven Temperature Initial time:	0 min.
	Initial Value:	140°C
	Final Time:	2 min.
	Final Value:	180°C
	Program Rate:	20°C/min.
	Column:	25 m OV101 HP capillary
	Amount Injected:	2 ul
	Split Ratio:	1/50

All samples were run in duplicate with 3 runs per replicate and the results calculated against the internal standard in comparison with a calibration standard.

Results and Discussion

Moisture tests indicated that the humidity of the soil environments was kept reasonably constant (Table 1).

.../3

Table 1: Moisture analysis of soil environments.

Time	Sample Number 1)			
	1	2	3	4
Start	13.7	11.9	19.1	18.0
Day 7	13.2	10.0	18.1	16.2
Day 14	13.0 2)	10.3	18.6	16.3
Day 21	13.4	10.1	18.1	16.0

1) 1. unsterilized soil, 2. sterilized soil, 3. unsterilized soil + 2% fatty acid salts, 4. unsterilized soil + 2% fatty acid salts.

2) % moisture based on differential dry weight measurement.

The linearity of the procedure was determined for the calibration standard and fatty acid salt solution and found to be very good (Table 2, Figures 1 and 2). The precision for both calibration standard and fatty acid moisture was within ± 3%, accuracy within ± 2%.

Data presented in Table 3 and figure 3 and 4, showing the recovery of C_9 and C_{10} fatty acids, illustrates the fatty acid content of the treated soils to be much greater initially than untreated soils.

In soils not treated with fatty acids (both sterilized and non-sterilized) quantitative low values of capric and pelargonic acids were observed (Table 3, Figure 4). Comparing the quantity of fatty acid recovered from the water leach to that of the chloroform ($CHCl_3$) leach, we can measure the capacity of the fatty acid to bind with soil particles (Table 3). In unsterilized soil, an average of 100% C_9 and 76.8% C_{10} acid had complexed with soil particles and was extracted by the chloroform leach. Similar conditions were observed in sterilized soil with 100% C_9 and 92.3% C_{10} acid complexing with soil particles. This illustrates the affinity between natural fatty acids and soil particles previously reported by others (Loos, 1958).

Soils treated with C_9 and C_{10} fatty acids also displayed binding to soil particles. In unsterilized soil, initially 3.7% C_9 and 10.1% C_{10} had bound to the soil but increased to 50.0% for both fatty acids within 24 hours. At 48 hours the bound fraction of fatty acid was 33.1% for C_9 and 37.6% for C_{10}, but the fatty acids had degraded in this time period to 3.2% (C_9) and 6.4%

.../4

(C_{10}) of their original levels. The sterilized soil initially bound 12.2% C_9 and 25.6% C_{10} acids. These values remained constant for 10 days averaging 13.2% C_9 and 23.3% C_{10} recovery in the chloroform leach. After day 10 the bound fraction increased to 68.2% C_9 and 82.2% C_{10}, although by day 20 only a small amount of the fatty acids were detected (Table 3).

Degradation of the fatty acids can be observed in figure 3 and 4. Untreated soils had very small quantities of the fatty acids naturally present but no degradation trend was observed, possibly due to the low magnitude and variation between samples (Figure 4).

Treated soils showed a strong trend towards degradation (Figure 3). Initial levels of capric and pelargonic acid decreased 93.6% and 96.8% respectively in unsterilized soil within 2 days. By day 20 only a trace of capric acid was detected (0.3%) and none of the pelargonic acid was found. A pronounced lag time in degradation was observed in sterilized soil. In these soils, ten days after treatment, the acids had degraded 4.1% for capric and 17.5% for pelargonic acid. From day 10 to day 20 the degradation of fatty acids in sterilized soils, proceeded rapidly with 96.4% total degradation of capric acid and 98.4% total degradation of pelargonic acid. This lag time in degradation for sterilized soil suggests re-colonization by micro-organisms that metabolize fatty acids (Bartha, 1965).

The degradation of pelargonic acid is shown to proceed more rapidly than capric acid (Fig. 3), although difference in rates is slight.

Conclusion

Capric and pelargonic fatty acids were found to occur naturally in low concentrations in a typical sandy loam lawn soil. In the environment, a large percentage of applied capric and pelargonic acids complex with soil particles (100% for C9, 76.8% for C10), as also described by Tarjan (1956) and Loos (1958). Degradation of capric and pelargonic acid proceeds very rapidly (within 2 days) in aerobic conditions with B-oxidation being the principal pathway of metabolism (Braids, 1975; Walkinshaw, 1968). The slightly faster degradation rate of pelargonic acid suggests the less complexed acid molecule to be metabolized easier than capric acid by micro-organisms.

Effects of leaching, adsorption and desorption by capric and pelargonic acid in a soil environment would be very minimal due to strong acid-soil particle interaction and acid binding to the upper portion of the soil (Loos, 1958). The effects of acid dissipation in the soil would be negligable due to acid-soil affinity and rapid total degradation of capric and pelargonic acids. Persistence of these two fatty acids in the environment is not of concern since biological degradation to normal levels found in soil occur within two days

REFERENCES

1. BARTHA, R.; D. PRAMER (1965) Features of a flask method for measuring the persistence and biological effects of pesticides in soil. Soil Science 100:68-70.

2. BERRIE, A.M.M. (1979) Possible role of volatile fatty acids and abscisic acid in the dormancy of oats. Plant Physiology 63:758-764.

3. BRAIDS, O.C., R.H. MILLER (1975) Fats, waxes and resins in soil. In "Soil Components" edited by V.E. Gieseking. Vol 2, P. 343-368, Springer, Berlin.

4. GUTHRIE, H.A. (1975) Introductory nutrition. 3rd edition. C.V. Mosby Co., St. Louis.

5. HOUSE, H.L.; A.R. GRAHAM (1967) Capric acid blended into foodstuff for control of an insect pest, *Tribolium confusum*. (Coleoptera:Tenebrionidae). Can. Ent. 99, P. 996.

6. IVLER, D.; J.B. WOLFE, S.O. RITTENBERG (1955). Studies on the Aerobic Oxidation of Fatty Acids by Bacteria. 5. Caprate Oxidation of Cell-free Extract of *Pseudomonas fluorescens*. J. Bacteriol. 70:99.

7. KRAUSE, F.P., W. LANG (1965) Vigorous Mold Growth in Soils after Addition of Water Insoluble Fatty Substances. Appl. Microbiol. 13:160.

8. LEWIS, H.L., G.T. JOHNSON (1967) Growth and oxygen uptake responses of *Cunninghamella echinulata* on even chain fatty acids. Dept. of Botany and Bacteriology. University of Arkansas.

9. LOOS, C.A. (1958) Certain fatty acids and hexadecylamine as nematocides. Plant Disease Reporter 42 (10):1179-1186.

10. MERCK INDEX (1976) 9th Edition. Encyclopedia of Chemicals and Drugs. Merck and Co. Inc. Rathway, N.J., USA.

11. METCALFE, L.D., A.A. SCHMITZ, J. PELKA (1966) Anal. Chem., 38, 514.

12. MAOUCAWI, J., E. FUSTEC, P. JANBU (1981) Decomposition of lipids in soils: free and esterified fatty acids, alcohols and ketones. Soil Biol. Biochem. 13, P. 461.

13. MUKHERJEE, S. (1952) Studies on degradation of fats by micro-organisms II. The mechanism of formation of ketones from fatty acids. Archives of Biochemistry and Biophysics 34:1, P. 23-33.

14. NELSON, W.I., S.L. TISDALE (1975) Soil Fertility and Fertilizers, Third Edition. MacMillan Publishing Co., Inc. New York.

15. NICOLAIDES, N. (1974) Skin lipids: Their biochemical uniqueness. Science 186, P. 19.

16. ROTHMAN, S. (1949) Susceptibility factors in fungus infections in man. New York Acad. of Sci. Trans. 12, P. 27.

17. ROTHMAN, S., A.M. SMILJANIC, A.W. WEIKAMP (1946) Mechanism of Spontaneous cure in puberty of ringworm of the scalp. Science 104 (2696):201-203.

18. SPRECHER, H. (1971) Lipids 6. P. 889.

19. STERN, A.M., J.Z. ORDAL, H.O. HALVORSON (1954) Utilization of Fatty Acids by and Lipolytic Activities of _Mucor mucedo_. J. Bacteriology. 68:24-27.

20. STUMPF, P.K. (1965) Lipid metabolism. In "Plant Biochemistry", edited by J. Bonner and J.E. Varner. Academic Press, New York, P. 323.

21. TARJAN, A.C., P.C. CHEO (1956) The nematode screening program of the University of Rhode Island. Bulletin 332 Agricultural Experimental Station. Rhode Island.

22. WAKSMAN, S.A., F.G. TENNY, K.R. STEVENS (1928) The role of Micro-organisms in the Transformations of Organic Matter in Forest Soils. Ecology. 9:126.

23. WALKINSHAW, C.H. (1968) Dependence of fatty acid chain length of oxygen uptake and decarboxylation by _Cronartium fusiforme_ aeciospores. Phytopathy 58:855-859.

24. WEITKAMP, A.W., A.M. SMILJANIC, S. ROTHMAN (1947) The free acids of human hair fat. J. Am. Chem. Soc. 69, P. 1936.

Table 2: Linearity of G.L.C. data for calibration standard and 5% concentration of fatty acid salts using amounts of 0.1-5.0 ml.

Sample mg/ml Fatty Acids Recovered ($x_n \pm O_n$)[1)]

Sample Volume Used (ml)	0.1		0.5		1.0		2.0		5.0	
Fatty Acids	C9	C10	C9	C10	C9	C10	C9	C10	C9	C10
Sample										
Cal. Std.	0.261	0.265	1.249	1.284	2.528	2.525	5.080	5.108	12.884	12.89
Std. o	±0.002	±0.002	±0.029	±0.015	±0.032	±0.008	±0.045	±0.024	±0.355	±0.17
FAS (5.0%)	0.086	0.092	0.453	0.487	0.907	1.020	1.841	1.930	4.601	4.85
Std. o	±0.001	±0.001	±0.002	±0.004	±0.010	±0.012	±0.021	±0.017	±0.030	±0.02

1) x_n mean of two replicates of three G.L.C. runs each.

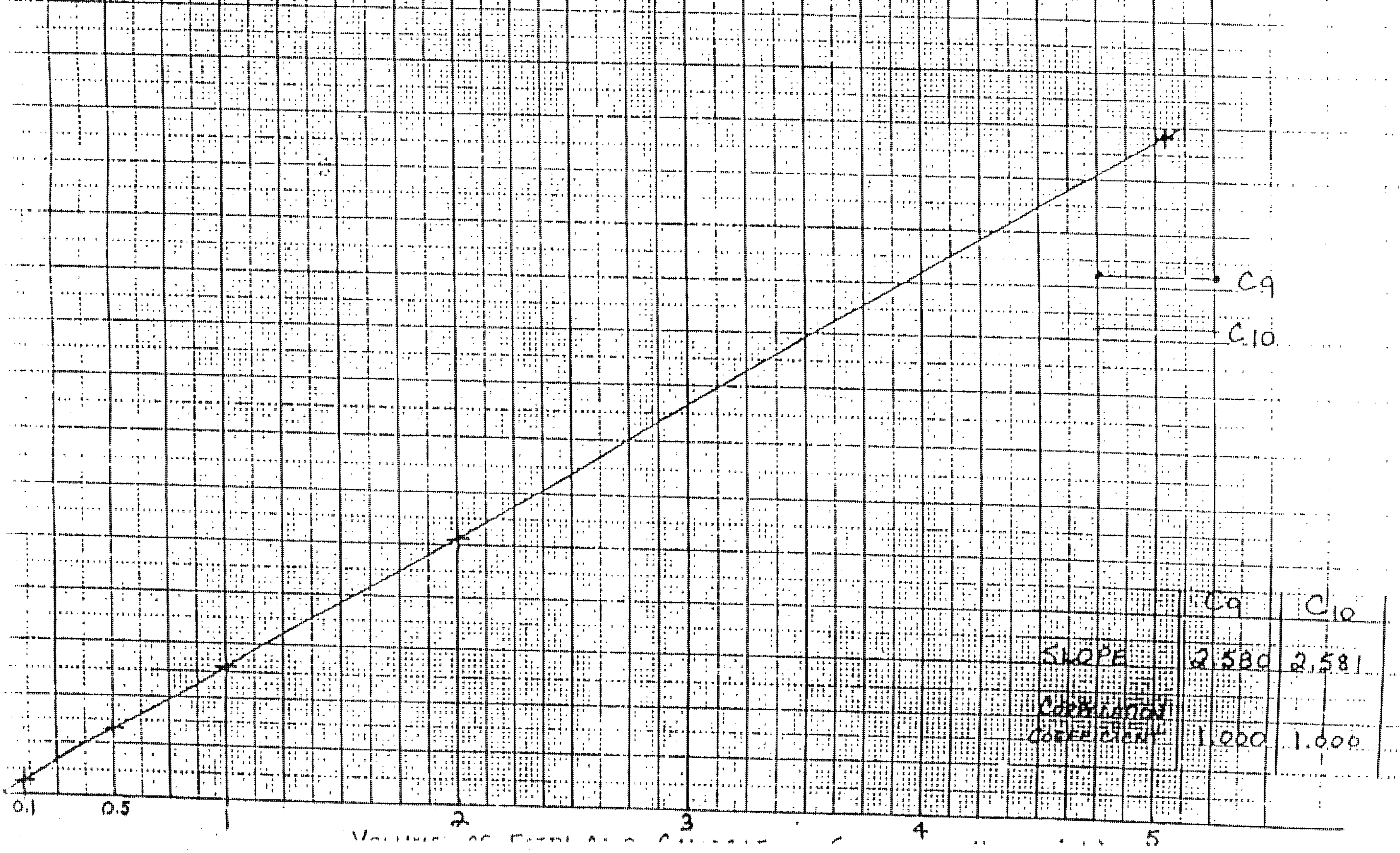
O^n_n = Standard Deviation

ble 3: Recovery of C9 and C10 Fatty Acids from Soil Samples.

me	Solvent	Quantity of Fatty Acids Recovered mg/ml							
		Untreated Unsterilized Soil		Untreated Sterilized Soil		Treated Unsterilized Soil		Treated Sterilized Soil	
		C_9	C_{10}	C_9	C_{10}	C_9	C_{10}	C_9	C_{10}
art	H2O	-	0.004	-	-	4.982	5.241	3.630	3.590
	CHCl3	0.007	0.010	0.013	0.016	0.189	0.587	0.506	1.236
	Combined	0.007	0.014	0.013	0.016	5.171	5.828	4.136	4.826
y 1	H2O	-	0.004	-	-	1.455	2.850	3.923	4.172
	CHCl3	0.008	0.009	0.013	0.015	1.468	2.848	0.516	1.049
	Combined	0.008	0.013	0.013	0.015	2.923	5.698	4.439	5.216
y 2	H2O	-	0.004	-	0.005	0.109	0.231	3.818	3.910
	CHCl3	-	0.029	0.007	0.018	0.054	0.139	0.641	1.443
	Combined	-	0.033	0.007	0.023	0.163	0.370	4.459	5.353
y 3	H2O	-	-	-	0.004	-	0.043	3.240	3.797
	CHCl3	-	0.005	0.023	0.038	-	0.103	0.501	1.091
	Combined	-	0.005	0.023	0.042	-	0.146	3.741	4.888
y 10	H2O	-	-	-	0.004	-	0.007	2.954	3.642
	CHCl3	-	-	0.008	0.047	0.009	0.101	0.456	0.984
	Combined	-	-	0.008	0.051	0.009	0.108	3.410	4.626
y 20	H2O	-	0.004	-	0.004	-	0.007	0.021	0.051
	CHCl3	-	0.005	0.010	0.050	-	0.008	0.045	0.143
	Combined	-	0.009	0.010	0.054	-	0.015	0.066	0.174

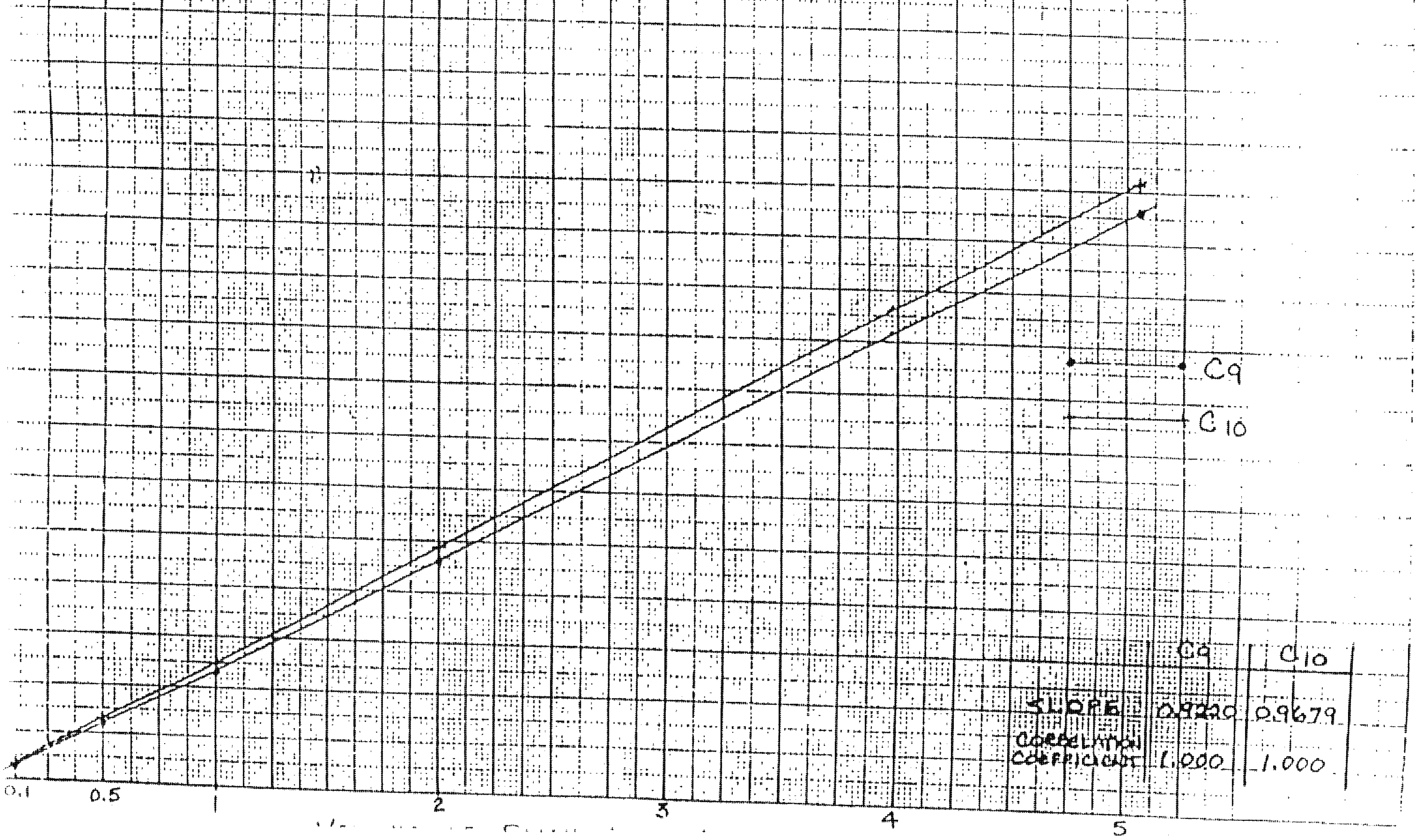
FIGURE 1: G.L.C. LINEARITY OF FATTY ACID CALIBRATION STANDARD

VOLUME (ml) of FATTY ACID CALIBRATION STANDARD USED VS (mg/ml) FATTY ACID RECOVERED



	C9	C10
SLOPE	2.580	2.581
CORRELATION COEFFICIENT	1.000	1.000

FIGURE 2: LINEARITY OF FATTY ACID SALT SOLUTION (0.5%)
VOLUME OF 0.5% SOLUTION USED VS. (mg/ml) FATTY ACIDS RECOVERED



	C9	C10
SLOPE	0.9220	0.9679
CORRELATION COEFFICIENT	1.000	1.000

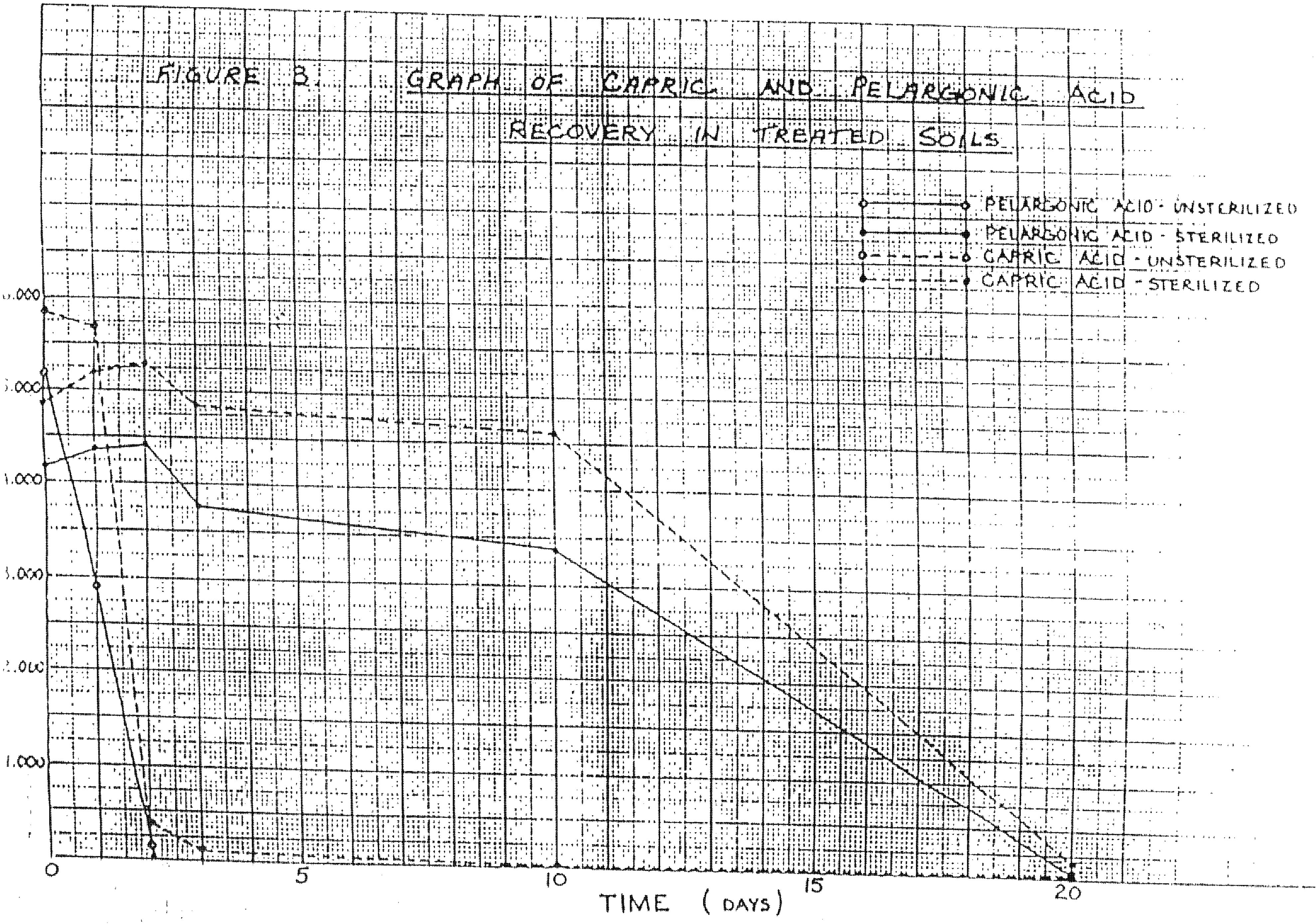
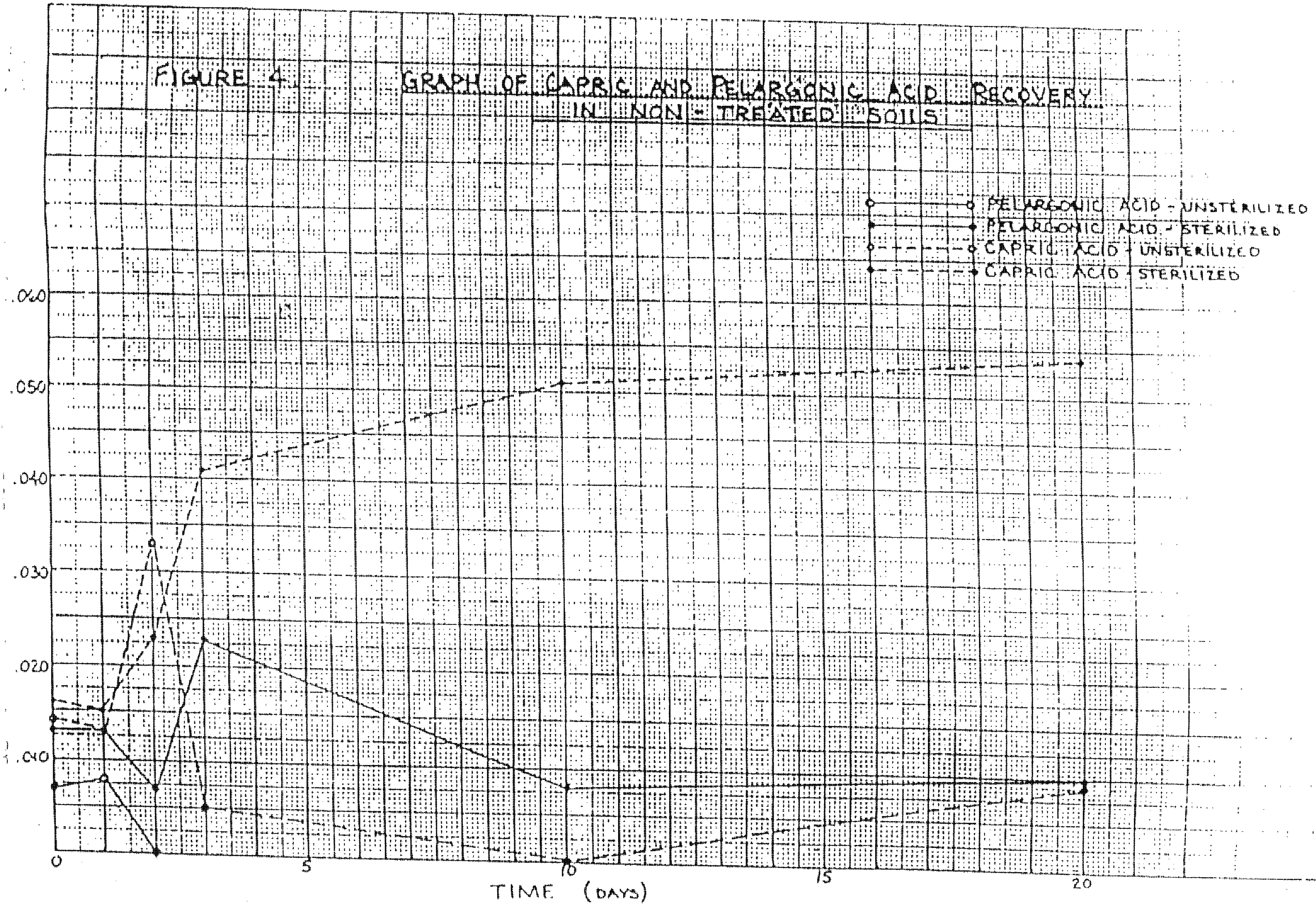


FIGURE 8. GRAPH OF CAPRIC AND PELARGONIC ACID RECOVERY IN TREATED SOILS

FIGURE 4. GRAPH OF CAPRIC AND PELARGONIC ACID RECOVERY IN NON-TREATED SOILS



THE USE OF PELARGONIC ACID AS A WEED MANAGEMENT TOOL

Steven Savage and Paul Zorner
Mycogen Corporation, San Diego, California

In 1995, the Mycogen Corporation introduced Scythe®, a burn-down herbicide containing 60% of the active ingredient, pelargonic acid. Pelargonic acid is a naturally occurring, saturated, nine-carbon fatty acid (C9:0). Pelargonic acid occurs widely in nature in products such as goat's milk, apples and grapes. Commercially it is produced by the ozonolysis of oleic acid (C18:1) from beef tallow.

Pelargonic acid has very low mammalian toxicity (oral, inhalation), is not mutagenic, teratogenic or sensitizing. It can cause eye and skin irritation and thus the formulated product carries a WARNING signal word (Category II). It has a benign environmental profile.

As a herbicide, pelargonic acid causes extremely rapid and non-selective burn-down of green tissues. The rate of kill is related to temperature, but under all but the coolest conditions the treated plants begin to exhibit damage within 15-60 minutes and begin to collapse within 1-3 hours of the application. Pelargonic acid is not systemic and is not translocated through woody tissues. It is also active against mosses and other cryptograms. Pelargonic acid has no soil activity. As with most burn-down herbicides, pelargonic acid does not prevent re-growth from protected buds or basal meristems. Many annual herbaceous weeds can be killed completely while larger weeds, grasses and woody plants may re-grow.

There are many practical applications of the rapid burn-down activity of pelargonic acid. It can be used for spot weeding, edging, lining, turf renewal, chemical pruning and suckering. It is particularly useful as a directed spray for killing annual weeds in container-grown woody ornamentals, under greenhouse benches and in other places where systemic herbicides can cause unwanted damage. If the spray of pelargonic acid does come in contact with some desired plants, the damage is strictly limited to those leaves which are actually sprayed. Pelargonic acid should be applied in at least 75 gallons/acre of total spray volume as activity declines at lower gallonages.

Evidence from P_{31} NMR studies suggests that the mode of action of pelargonic acid is not based on direct damage to cell membranes. Pelargonic acid moves through the cuticle and cell membranes and lowers the internal pH of the plant cells. Over the next several minutes the pools of cellular ATP and Glucose-6-phosphate decline. Only later is there evidence of membrane dysfunction which eventually leads to cell leakage, collapse and desiccation of the tissue. This chain of cellular events appears to allow pelargonic acid to synergize the activity of certain systemic herbicides such as glyphosate.

In general, burn-down herbicides are antagonistic to the activity of systemic herbicides, but in a tank mix pelargonic acid has been shown to allow greater and more rapid uptake of glyphosate without interfering with translocation. This type of synergy is completely distinct from the enhancement seen with various surfactants used as adjuvants or formulation components for glyphosate. By using high volume applications of a tank mix it is possible to combine the rapid kill of pelargonic acid with the systemic action of glyphosate. At low application volumes (e.g. 20-30 GPA), pelargonic acid still enhances glyphosate uptake and improves its overall performance, but there is no immediate burn of the treated foliage.

Scythe herbicide was registered for non-crop use in 1995 and a crop registration is expected in 1996. This commercial formulation of pelargonic acid has a wide range of weed control applications both as a contact, non-selective agent and as a tank mixing partner with systemic herbicides such as glyphosate.

U.S. Environmental Protection Agency

Pesticides: Regulating Pesticides

Recent Additions | Contact Us | Print Version Search: GO

EPA Home > Pesticides > Regulating Pesticides > Registering Pesticides > Regulating Biopesticides > Biopesticide Active Ingredient Fact Sheets > Pelargonic Acid (217500)

- Registration
- Reregistration
- Pesticide-Producing Establishments
- Laws
- International Issues
- Adverse Effects Reporting
- Storage & Disposal
- Restricted & Canceled Uses
- Pesticide Tolerances
- Registration Information Sources

Pelargonic Acid (217500) Fact Sheet

Fact Sheet	Technical Doc	**Products**	**Registrants**	Regulatory Activity	**FR Notices**	Bibliography

SUMMARY

Pelargonic acid is present in many plants. It is used as an herbicide to prevent growth of weeds both indoors and outdoors, and as a blossom thinner for apple and pear trees. The U.S. Food and Drug Administration (FDA) has approved this substance for use in food. No risks to humans or the environment are expected when pesticide products containing pelargonic acid are used according to the label directions.

Issued: 4/00

I. DESCRIPTION OF THE ACTIVE INGREDIENT

Pelargonic acid is a chemical substance that is found in almost all species of animals and plants. Because it contains nine carbon atoms, it is also called nonanoic acid. It is found at low levels in many of the common foods we eat. It is readily broken down in the environment.

II. USE SITES, TARGET PESTS, AND APPLICATION METHODS

Pelargonic acid has two distinct uses related to plants: weed killer and blossom thinner. [*Note*: The substance can also be used as a sanitizer, a use not addressed in this Fact Sheet.]

> **Weed killer** Growers spray pelargonic acid on food crops and other crops to protect them against weeds. For food crops, pelargonic acid is allowed to be applied from planting time until 24 hours before harvest. The pre-harvest restriction assures that little or no residue remains on the food. The chemical also controls weeds at sites such as schools, golf courses, walkways, greenhouses, and various indoor sites.
>
> **Blossom thinner** Growers use pelargonic acid to thin blossoms, a procedure that increases the quality and yield of apples and other fruit trees. Thinning the blossoms allows the trees to produce fruit every year instead of every other year.

III. ASSESSING RISKS TO HUMAN HEALTH

Pelargonic acid occurs naturally in many plants, including food plants, so most people are regularly exposed to small amounts of this chemical. The use of pelargonic acid as an herbicide or blossom thinner on food crops is not expected to increase human exposure or risk. Furthermore, tests indicate that ingesting or inhaling pelargonic acid in small amounts has no known toxic effects. Pelargonic acid is a skin and eye irritant, and product labels describe precautions that users should follow to prevent the products from getting in their eyes or on their skin.

IV. ASSESSING RISKS TO THE ENVIRONMENT

Pelargonic acid is not expected to have adverse effects on non-target organisms or the environment. Toxicity tests on non-target organisms, such as birds, fish, and honeybees, revealed little or no toxicity. The chemical decomposes rapidly in both land and water environments, so it does not accumulate. Because pelargonic acid is an herbicide, it could harm non-target plants if pesticide spray drifted beyond the intended target area. Users are required to minimize drift by using large spray droplets and taking other precautions.

V. REGULATORY INFORMATION

In 1992, EPA registered (licensed for sale) the first pesticide products containing pelargonic acid. As of November 1999, four pesticide products registered as weed killers or blossom thinners contained this active ingredient.

The Food and Drug Administration (FDA) has approved pelargonic acid as a food additive, and as an ingredient in solutions used commercially to peel fruits and vegetables. These approvals indicate that FDA considers it safe for humans to eat food containing small amounts of pelargonic acid.

VI. PRODUCER INFORMATION

Enforcer Products Inc.
PO Box 1060
Cartersville, GA 30120

Mycogen Corporation
5501 Oberlin Drive
San Diego, CA 92121

West Agro, Inc
501 Sante Fe
Kansas City, MO 64105

VII. FOR FURTHER INFORMATION, CONTACT:

Brian Steinwand
Biopesticides and Pollution Prevention Division (7511C)
Office of Pesticide Programs
Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Phone: 703-305-7973 (or 308-8712)
Fax: 703-308-7026

e-mail: steinwand.brian@epa.gov

DISCLAIMER: *The information in this Biopesticide Fact Sheet is a summary only. Consult the person listed above or the Biopesticides Web Site for more information.*

Last updated on Monday, April 4th, 2005
URL: file:///C:/Documents%20and%20Settings/u363630/Local%20Settings/Temporary%20Internet%20Files/OLK4D/EPA%20Pelargonic%20acid%20(217500)%20Fact%20Sheet.mht

Tex-R Geodiscs® are fabric disks that have been treated with Spin Out™ and work the same as the disks mentioned above. They prevent weed growth by excluding light and pruning the roots of weed seeds that are blown onto the fabric. They provide effective weed control for up to three years and can be moved from pot to pot. For distributors, contact Texel USA (22).

Professor Bonnie Appleton at Virginia Tech recently conducted research using Geodiscs on container-grown willow oaks (23). The Geodiscs suppressed all weeds completely. Trees grown in the pots with Geodiscs had higher top dry weights and root dry weights than both those grown without any form of weed control and those sprayed with a conventional herbicide.

Bioherbicides

A recently introduced organic weed control is corn gluten meal (CGM), a by-product of corn syrup processing. CGM is a pre-emergent herbicide, applied in early spring. It works best when applied to the top ¼ inch of soil. It has no carry-over into the second year of growth, so it must be applied every year. CGM contains 10% nitrogen and acts as a slow-release fertilizer for the crop. CGM has been patented and is currently being sold as a herbicide (see the **Suppliers** section for sources), but treating a large area can be quite expensive. Wheat gluten meal has many of the same effects as CGM, but it has not been patented and so may be more affordable.

More recent research has revealed that corn gluten hydrosylate (CGH), which is made from corn gluten meal, is more effective than corn gluten meal for controlling weeds (24) and could be applied at less than half the rate for effective weed control. Iowa State University—patent holder of corn gluten meal as a natural herbicide—maintains a web list of licensed suppliers for this product (see **Resources: Suppliers**).

There are some new environmentally friendly contact herbicides that break down quickly and provide options for weed control in container nurseries around irrigation risers and perimeter areas, as well as for general use in field nursery production. One class of products—Weed Eraser™, Scythe™ —is made from pelargonic acid, a fatty acid found in plants and animals. They work by rapidly lowering the pH of any plant sprayed, which weakens the cell walls and kills the weed, usually within two hours. A second class of products—Nature's Glory™, Burnout™, and Bioganic™—contain acetic acid (vinegar), lemon juice, eugengol, thyme oil, orange oil, and other natural ingredients. All of these products work as contact herbicides and control, with varying degrees of success, broadleaf and grassy weeds. Application to nursery plants should be avoided, and several applications may be necessary to kill perennial weeds.

Fertilization

Container nursery production has become a huge success largely due to advances in media and fertilizer combinations. This has resulted from several decades of research collaborations between land-grant universities, commercial nurseries, and the fertilizer industry. Commercial synthetic fertilizers (including slow-release and liquid fertilizers) have played a key role in this picture. Detailed information on commercial nursery mixes and fertilizer systems is widely available through the Cooperative Extension Service.

As organic production becomes standardized under the new federal Rule, more and more nursery growers are looking at organic fertilizers and wondering how they can be used. Unlike synthetic greenhouse fertilizers, organic fertilizers have been given little research to support their use in a nursery mix recipe. Most of the following material will focus on organic fertilizers for container nursery production. Regardless of fertilizer type—whether the source is synyhetic or organic—in sustainable nursery production the emphasis is on zero runoff. Excessive nitrates and phosphorus are the most common problems in runoff water (25).

J. Pesticide Sci. 27, 298-306 (2002)

Commentary

Strategies for the Use of Natural Products for Weed Management[1]

Stephen O. DUKE,* Agnes M. RIMANDO, Scott R. BAERSON, Brian E. SCHEFFLER,
Eiji OTA[†,#] and Regina G. BELZ[††]

Natural Products Utilization Research Unit, Agricultural Research Service, United States
Department of Agriculture, P. O. Box 8048, University, MS 38677, USA
[†] *Bio-Technology Group, Advanced Technology Laboratory, KUBOTA Corporation,*
5-6, Koyodai, Ryugasaki, Ibaraki 301-0852, Japan
[††] *Department of Weed Science, University of Hohenheim, Institute for Phytomedicine*
360, Otto-Sander-Strasse 5, 70599 Stuttgart, Germany

(Received June 17, 2002)

Natural products have not been utilized as extensively for weed management as they have been for insect and plant pathogen management, but there are several notable successes such as glufosinate and the natural product-derived triketone herbicides. The two fundamental approaches to the use of natural products for weed management are: 1) as a herbicide or a lead for a synthetic herbicide and 2) use in allelopathic crops or cover crops. New technologies, such as molecular biology, provide tools for expanding the use of natural products in weed management. Strategies for implementation of these approaches are discussed, along with examples.

Key words: allelochemical, allelopathy, herbicide, natural products, phytotoxin, weed management.

1. INTRODUCTION

Unlike synthetic pesticides, natural products can be either biosynthetically produced in the crop to be protected or used directly as a pesticide or a pesticide lead. Thus, there are two fundamental approaches to the use of natural products for weed management. The first is to use them as allelochemicals in allelopathic crops or cover crops to manage weeds, in much the same way that natural products have been manipulated in crops to manage insects and plant pathogens. In many ways, this is a type of biocontrol, especially when a cover crop is used to control weeds in a crop. The advent of transgenic methods to manipulate secondary product production in plants offers a powerful new tool in implementing allelopathy approaches to weed management.

The other strategy is to use them directly as herbicides or as leads for synthetic herbicides. Natural products have been extremely lucrative sources of pharmaceuticals and, to a lesser extent, pesticides. Compared to use of natural products as insecticides and fungicides, natural products have not been utilized as extensively for weed management, but there are several notable successes. Modern technology may increase their use in weed management. Natural products offer rapid access to novel chemical structures often with new molecular target sites.[1)] Furthermore, there is a perception that natural products are safer than synthetic pesticides, and indeed, their environmental toxicology profiles are generally more benign than those of synthetic herbicides. The topic of natural products in weed management has been previously reviewed.[2–4)] This review updates and expands this topic, covering new strategies and technologies for exploiting natural products in weed management.

2. USE OF NATURAL PRODUCTS IN CROP ALLELOPATHY

Allelopathy can negatively or positively impact crop production, but most of the literature deals with crop losses due to allelopathy.[5)] Allelopathy of weeds can be a component of their interference with crops. Allelochemicals in some crop residues can eventually lead to autotoxicity in continuous monoculture cropping systems, reducing crop yield. Likewise, allelochemicals have been implicated in reduced yields of certain crops planted after certain other crops. These processes have

---

[*] To whom correspondence should be addressed.
E-mail: sduke@ars.usda.gov

[#] Present address: 6-33-5-508 Kiba-cho, Minato-ku, Nagoya, Aichi 455-0021, Japan

[1] A plenary lecture at the 27th annual meeting of the Society.

been described in several studies,[5] although few of these studies conclusively determine the allelochemical contribution to crop losses. Fewer studies have focused on the potential for allelopathic crops to control weeds.

Allelopathic cover crops and crops are an attractive strategy for the use of natural products to manage weeds. Theoretically, crops producing phytotoxic allelochemicals can interfere with competing weeds sufficiently to allow significant reductions in the use of other weed management options, including synthetic herbicides. The often relatively poor efficacy and resulting reduced yields, compared to herbicides, has limited this approach, except in specific situations. In rice,[6] wheat,[7] barley,[8] and a few other crops, geneticists and breeders have tried to produce allelopathic crops with which less herbicide might be used. This approach has not yet yielded a commercial variety with such a trait. Transgenic approaches to produce highly allelopathic crops might be more successful. We will discuss allelopathy and allelochemicals in several major cereal crops which are known to have allelopathic potential.

2.1 *Allelochemicals in grain crops*

The incidence of growth inhibition of certain weeds and production of phytotoxic symptoms by plants and their residues is well documented for many crops, including all major grain crops such as rice, rye, barley, sorghum, and wheat. To have a major impact on herbicide use, substitution of allelopathy for synthetic herbicides in these crops is the most promising approach.

All plants produce secondary metabolites that are phytotoxic to some degree, and in a small number of cases their release into the environment and capability of causing allelopathic effects towards a number of noxious weeds has been demonstrated. Crop allelopathy can be exploited for weed management by the release of allelochemicals from intact roots of living plants or decomposition of plant residues. In annual crops, root exudation of the phytotoxin by the crop is the preferred mechanism.

Barley allelochemicals. The success of barley (*Hordeum vulgare* L.) as a smother crop is attributed to physical competition as well as the direct release of allelochemicals. Phytotoxicity of barley residues has also been reported.[9–12] Two main categories of phytotoxic metabolites are claimed as the allelopathic agents in barley: phenolic acids and alkaloids.

Phenolic acids have been identified in residues[13] and root exudates[14] of barley. Chemical analysis of inhibiting compounds in barley residues detected ferulic, *p*-coumaric, vanillic, and *p*-hydroxybenzoic acids in aqueous extracts of straw and alcoholic extracts of roots.[13] The exudation of these compounds by intact roots along with benzoic, caffeic, *o*-coumaric, *trans*-cinnamic and gentisic acids has also been demonstrated. The competitiveness of *H. vulgare* cultivars was shown to be linked to a high exudation of total phenolics, whereby in particular *p*-coumaric acid was only detectable in root exudates of highly competitive cultivars and could therefore act as distinctive indicator for competitiveness of *H. vulgare* cultivars.[14] Although the phytotoxicity of phenolic acids is well known, their role and significance in the allelopathy of barley at the levels released is not clearly understood.

Two alkaloids, gramine and hordenine, (Fig. 1) have been identified in residues[15–18] and root exudates[11,19] of barley. Furthermore, gramine is found on the leaf surface and in leaf leachates of barley.[17] Gramine and hordenine have been isolated from shoot and root tissue of different *Hordeum* spp., whereby significant differences in the alkaloid contents between species, genotypes and cultivars appeared. The production of gramine was revealed to be under strong genetic control with usually higher contents in ancestral barley or *H. vulgare* landraces than in modern cultivars. Gramine content in ancestral barley reached up to 1.5 mg/g fresh weight[16,18] and $>$10 mg/g dry weight[15] in shoot tissue and up to 0.9 mg/g fresh weight in root tissue,[16] however some barley lines and *H. vulgare* cultivars produced virtually no gramine at all. Small fractions of up to 0.04–0.18% of the total gramine found in leaves were also present on the leaf surface and could be totally removed along with some inner gramine by artificial rain.[17] The implication of surface gramine in the allelopathy of barley has not yet been investigated.

The production of hordenine appeared to be highly responsive to stressful conditions. Hordenine contents in root tissues of *Hordeum* spp. varied between 133–327 μg/g fresh weight, increasing up to 2.6 mg/g fresh weight under low light intensity.[18] Although the phytotoxicity of barley residues has been reported, and gramine and hordenine inhibited growth of various weeds, a correlation between the alkaloid content of residues or the actual release of alkaloids from residues and the inhibitory effect has not yet been investigated. In contrast, the inhibitory action of barley exudates against weeds has been demonstrated in several bioassays,[11,19–21] and the presence of gramine and hordenine in exudates of germinating seedlings and from intact roots was confirmed. Bioassays with synthetic analogues of gramine and hordenine at the levels quantified in exudates of germinating seedlings proved a phytotoxic effect.[11,19,20] Therefore, gramine and hordenine are believed to play a major role in the allelopathy of barley.

Hydroxamic acids, a group of major allelochemicals involved in the allelopathy of other Gramineae, could be detected as 2,4-dihydroxy-1,4-benzoxazin-3-one (DIBOA) (Fig. 1) in shoot tissue of wild *Hordeum* species, but not in cultivated barley.[22]

Rye allelochemicals. Rye is believed to be the most suppressive cover crop among several small grains.[23] Numerous studies using rye as green manure or in cover crop mulch systems demonstrated a weed suppressive ability often as efficient as standard herbicide applications.[10,24] The contribution of allelopathy to the suppression of weeds in rye mulch situations is estimated to account for up to 63% reduction in weed biomass.[25] Although investigations on the allelopathic activity of rye focus on residues, bioassays and field studies further determined root exudates as potential means by which competitive rye cultivars reduce weed growth.[26-28] The two main categories of phytotoxic metabolites claimed as the allelopathic agents are phenolic acids and cyclic hydroxamic acids.

The exudation of DIBOA and 2,4-dihydroxy-7-methoxy-1,4-benzoxazin-3-one (DIMBOA) (Fig. 1) and the allelopathic potential of rye root exudates containing hydroxamic acids had been demonstrated.[26,28] Weed suppression by allelopathy of living rye proved to be significant under field conditions, with substantial evidence for the allelopathy being due to hydroxamic acids. A rye cultivar exuding large amounts of DIBOA reduced the total weed biomass by 83% compared to a wheat cultivar unable to exude hydroxamic acids and by 76% compared to *Avena strigosa*, a highly competitive crop, unable to produce hydroxamic acids.[27] Since the exudation of DIBOA by rye did not correlate with the content in roots, an active exudation depending on a specific regulation factor independent of type or content of hydroxamic acids in root tissues is assumed.

Although DIBOA and 2-benzoxazolinone (BOA) (Fig. 1) had been identified as the most active compounds in rye extracts, they accounted for only 12% of the total phytotoxicity.[29] Therefore, other phytotoxic compounds or additional transformation products may also play a role in the allelopathy of rye. BOA, for example, is rapidly degraded by microbial hydrolysis in non-sterile soils,[30] as well as by root-colonizing bacteria,[31] to the phytotoxic 2-amino-3*H*-phenoxazin-3-one, which is further acetylated by root bacteria to 2-acetylamino-3*H*-phenoxazin-3-one. 2-Amino-3*H*-phenoxazin-3-one and its acetyl derivative are actinomycin analogues and, thus naturally occurring antibiotics, produced by a number of fungi and bacteria. Even though 2-amino-3*H*-phenoxazin-3-one proved to be much more phytotoxic than its precursor BOA, its potential for increasing the allelopathic effect of rye is questionable, since the inhibitory effect of BOA in bioassays was significantly reduced by microbial transformation.[31] This would explain the findings of decreasing phytotoxicity of rye mulch in non-sterile soil.[32]

Rice allelochemicals. Allelopathic rice cultivars have been identified from field studies conducted over the past decade in approximately 3.5% of the accessions tested.[33-35] Allelopathy was demonstrated against the common rice weeds barnyardgrass (*Echinochloa crus-galli*), ducksalad (*Heteranthera limosa*), and redstem (*Ammannia auriculata*). As a consequence, studies were conducted using laboratory assays that have been developed in order to study rice allelopathy in more controlled conditions. Examples of these assays include the plant box method,[36] relay seeding,[37] root exudate trapping system,[38] and petri dish assay.[39] In some cases, bioassays have been utilized in the isolation of allelochemicals in rice.

Compounds that have been isolated from selected allelopathic rice varieties and identified as the putative allelochemicals are rather ubiquitous in plants, most of which are common phenolics, aromatic acids, long-chain hydrocarbons, fatty acids, and sterols.[38,39] More recently, the inhibitory activity of extracts from straw of four rice cultivars on barnyardgrass seed germination was reported[40] and, again, activity was attributed to *p*-hydroxybenzoic acid (in cultivars Gin shun and Juma 10), *p*-coumaric acid (in cultivar Kasawala mundara), and ferulic acid (in cultivar Philippine 2). In another study, the activity of phenyl ammonia lyase was positively correlated with phenolic content of the aqueous extracts of the leaves of six allelopathic rice varieties.[41]

Contrary to these findings, *p*-coumaric acid was demonstrated not to be the phytotoxic constituent from the allelopathic rice variety Taichung Native 1 root extract when tested against barnyardgrass.[42] Phytotoxic activity was found in other fractions that do not contain *p*-coumaric acid following bioassay-guided isolation. *p*-Coumaric acid was also found to be only weakly inhibitory against lettuce germination compared to the tricyclic diterpenes that were also isolated from rice husk of cultivar Koshihikari.[43] Olofsdotter *et al.*[44] also showed that phenolic acids are possibly not the allelochemicals in rice, based on measurement of tolerance to phenolic acids among traditional rice cultivars adapted to environments having inherently different phenolic acid concentrations. This study further showed that the maximum rate of release of phenolic acids during the first month of growth, the time period of greatest allelopathic activity, was approximately 10μg/plant/day. This rate would not provide concentrations of phenolic acids that would be at phytotoxic levels. Using LC/MS and ^{1}H and ^{13}C-NMR spectroscopy, glucosides of resorcinol, flavones and hydroxamic acids were found as the allelochemicals in rice, negating an earlier study where common phenolic and fatty acids were identified as the rice allelochemicals.[45]

The tricyclic diterpenes momilactones, oryzalexins, and ineketone (Fig. 1) are perhaps the secondary metabolites that are unique to rice. These compounds are growth inhibitors and are also phytoalexins. Momilactones A and B, and ineketone were isolated from the seed husk of *Oryza sativa* L. cv. *Koshihikari*, and were shown to be inhibitory towards lettuce root germination and growth of rice root.[43,46] Momilactone C was later isolated from this cultivar as a minor component, and showed weak inhibitory activity towards lettuce seed germination.[47] Momilactones A and B, and oryzalexins A and C were characterized as the allelochemicals from extracts of the straw of *O. sativa* cv. *Haresugata.*[48] Momilactone B exhibited the strongest inhibitory activity against the weed species tested, namely, *Amaranthus lividus*, *Digitaria sanguinalis*, and *Poa annua*. Whether or not the momilactones and oryzalexins are the true allelochemicals in rice requires further investigation. These compounds have been isolated from cultivars that are not known to be allelopathic. Furthermore, there are no reports on these compounds being isolated from the roots, nor on their release in the soil.

The isolation and identification of rice allelochemicals is yet to be fulfilled. Two lettuce growth-inhibiting substances were isolated from the neutral fraction of seedlings of *O. sativa* cv. Nipponbare, but have not been characterized. Large-scale re-isolation of the active compounds is reportedly underway.[49] In our laboratory, work is also continuing on the isolation of allelochemicals from Taichung Native 1, this being done in a bioassay-directed manner using 24-well plates.

Sorghum allelochemicals. Several *Sorghum* species are allelopathic, producing several phytotoxins, including sorgoleone (2-hydroxy-5-methoxy-3-[(*Z,Z*)-8′,11′,14′-pentadecatriene]-*p*-benzoquinone) (Fig. 1) and its phytotoxic analogues, as well as dhurrin, *p*-hydroxybenzoic acid and *p*-hydroxybenzaldehyde.[50,51] Sorgoleone and its analogues account for most of the phytotoxicity, since they represent as much as 80–90% of the content of droplets exuded from root hairs[52] and are the most phytotoxic compounds produced.

Of particular interest is that sorgoleone and its analogues are potent photosystem II inhibitors,[53,54] as well as sorgoleone being an excellent inhibitor of hydroxyphenylpyruvate dioxygenase (HPPD).[55] The relative importance of these two modes of action in the field has not been determined. Dual molecular target sites are desirable to prevent the evolution of resistance.

2.2. *Genetic manipulation of allelochemicals in crops*

Despite the fact that these major crops produce allelochemicals, traditional breeding has not produced a cultivar of any of them which is sold as an allelopathic variety. While significant effort has been invested in the genetic manipulation of biosynthetic pathways producing phytoalexins and other secondary plant metabolites via transgenic approaches, similar efforts targeting allelochemicals are, to our knowledge, absent from the literature. However, strategies for transgene approaches to allelochemical manipulation have been proposed.[56–58] Part of the reason for the lack of progress in genetic manipulation of allelochemicals via biotechnology is the lack of identified gene sequences encoding the biosynthetic enzymes for these pathways. An exception is the hydroxamic acid pathway in maize leading to the formation of DIBOA, where all five genes required for biosynthesis have been identified.[59] In this example, a forward genetics approach was employed using the maize *bx1 (benzoxazineless)* mutant,[60] however this strategy is more suitable for a relatively well characterised genetic system and is impractical for the majority of allelochemical-producing species.

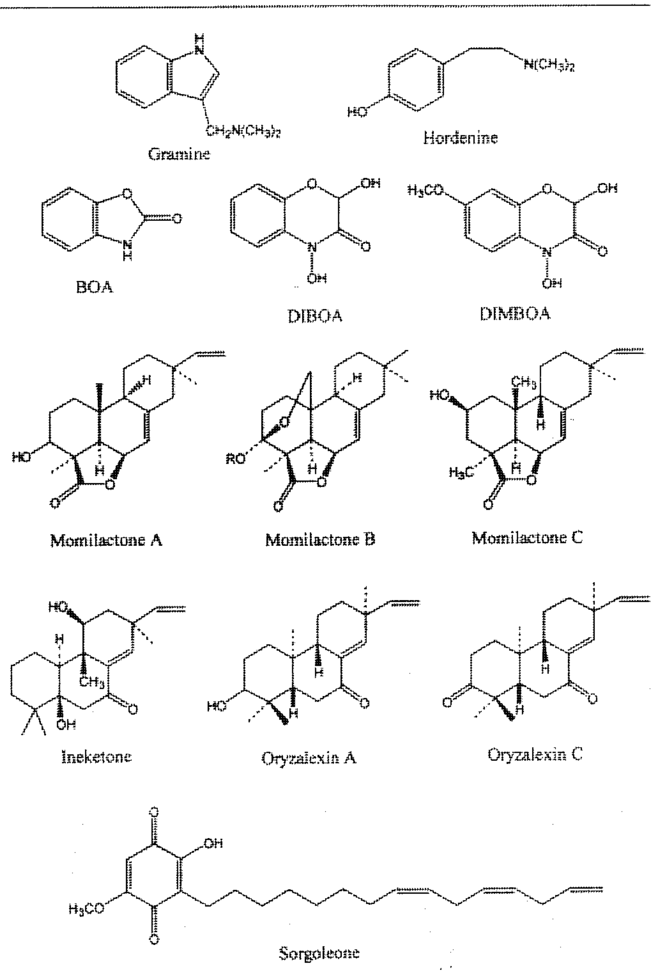


Fig. 1 Structures of some of the allelochemicals mentioned in the text.

Alternative gene isolation strategies which are suitable for most allelopathic species include differential screening approaches such as suppression subtractive hybridization[61] or differential display.[62] While these techniques do not require the use of genetic mapping data to facilitate gene isolation, there is a requirement that the gene of interest exhibits differential expression under some predetermined set of experimental or developmental conditions. Alternatively, a species such as *Artemisia annua*, which includes biotypes both possessing and lacking peltate secretory glands[63,64] could be used as starting material for differential screens.

Frequently, secondary metabolites are produced by specific cell types within plants. Thus the corresponding genes involved in their biosynthesis may be specifically or preferentially expressed within those cells. If substantial amounts of the compound are produced, the system could be amenable to Expressed Sequence Tag (EST) analysis.[65] Within specialised cells, such as root hairs or glandular trichomes, the genes involved may represent the most highly expressed mRNA species within that cell type, and can thus be identified within a random sampling of a few thousand sequences. Recently, this approach has been successful in the identification of genes involved in essential oil (monoterpene) biosynthesis in peltate glands of *Mentha piperita*.[66]

A particularly intriguing target for genetic manipulation is the allelochemical sorgoleone, first identified in root exudates of *Sorghum bicolor*.[67] In addition, roots of *S. bicolor* can be propagated under soil-less conditions that either promote or inhibit root hair formation (M. Czarnota, *unpublished*). Thus, an excellent source of starting material is readily available for performing differential screens as described above. The observation that sorgoleone is the major component found in *S. bicolor* root exudates also suggests that an EST-based approach would be a logical strategy to pursue. Our laboratory has been actively pursuing the isolation of sorgoleone biosynthetic genes using both suppression subtractive hybridization as well as EST analysis. Highly purified root hair preparations can readily be obtained from *S. bicolor* (Fig. 2), and from this starting material a cDNA library was prepared for the development of a sequence database comprised of 5000 randomly chosen sequences.

Preliminary EST data from this study as well as suppression subtractive hybridization results have identified several promising gene candidates (Table 1). In addition, we have recently developed a secondary screen for determining the expression patterns of candidate sequences based on real-time PCR in the presence of the double stranded DNA-specific fluorophore, SYBR Green.[68] Figure 3 illustrates the utility of real time PCR for follow-up analyses of candidate sequences. By comparing PCR amplification signals using cDNAs

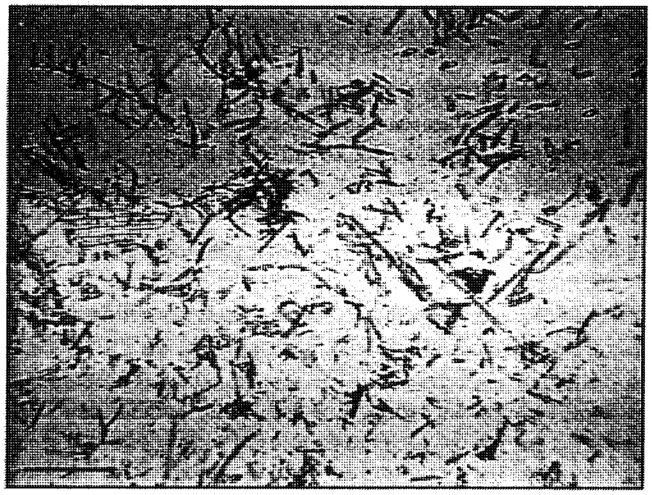


Fig. 2 Light micrograph of highly-enriched *S. bicolor* root hairs, isolated essentially as described by Bucher *et al.*[69] Bar = 200 μm.

Table 1 Selected clones identified from suppression subtractive hybridization and/or EST analysis, potentially encoding sorgoleone biosynthetic enzymes. The predicted functions, scores, and E values were derived from the BLASTX output from the NCBI BLAST server (http://www.ncbi.nlm.nih.gov/BLAST/).

Clone I.D.	Predicted Function	Score	E value	Identity (%)
BS3_G07	O- methyltransferase Maize (P47917)	85.1	9.00E-17	39/81 (48)
BS3_H11	O- methyltransferase Maize (P47917)	61.6	1.00E-09	30/51 (58)
BS4R_H12	O- methyltransferase Maize (P47917)	97.8	2.00E-20	49/89 (55)
BS6R_D08	O- methyltransferase Maize (P47917)	85.1	2.00E-16	46/95 (48)
BS4R_C10	cytochrome P450 *Lolium rigidum* (T06238)	84	3.00E-16	38/46 (82)
BS1R_D03	omega-3 fatty acid desaturase Wheat (T06238)	49.7	5.00E-06	27/62 (43)

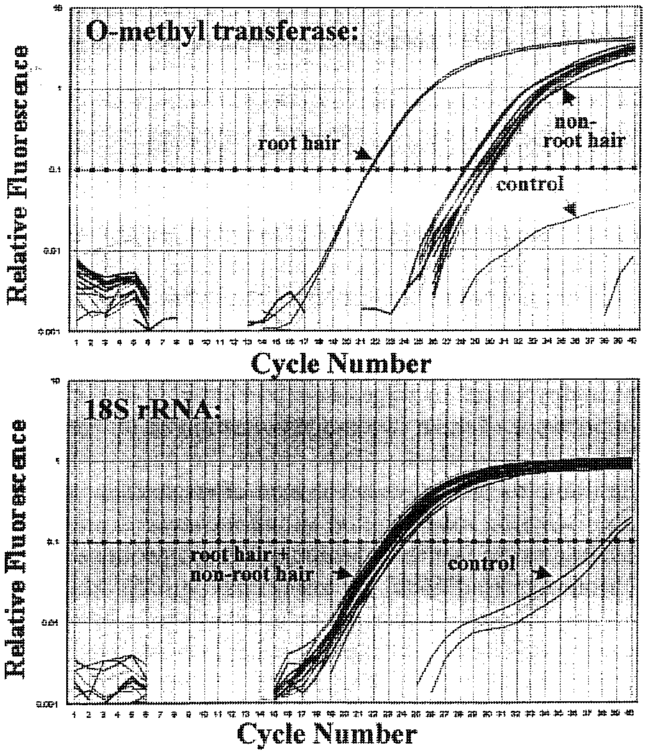


Fig. 3 Representative real-time PCR results generated using an ABI 5700 sequence detection system and sequence-specific primers for a putative O-methyl transferase.
Upper panel: Sybr Green I signals generated from root hair cDNA vs. "non-root hair" (whole root, immature and mature leaf, stem, and developing panicle). Lower panel: same cDNAs used as in upper panel showing signals generated from an internal control gene (18S ribosomal RNA).

prepared from six different *S. bicolor* tissues (root hair, whole root, immature leaf, mature leaf, stem, and panicle), the relative expression levels in these tissues can be rapidly determined. In the example shown (Fig. 3), a putative O-methyl transferase identified by both EST analysis and suppression subtractive hybridization is shown to exhibit highly root hair-preferential expression. Additional work is being performed to determine if this particular enzyme is capable of methylating sorgoleone precursors and structurally related molecules via heterologous expression in *Escherichia coli*. Ultimately, stably-transformed *S. bicolor* plants or root cultures will be employed to directly demonstrate the involvement of this gene in the sorgoleone biosynthetic pathway.

While efforts toward the genetic manipulation of allelochemical pathways are at a very preliminary stage, the tools are now at hand to make significant strides in this area. The likelihood that many, if not most, allelochemicals are synthesized in a cell type or organ-specific manner will greatly facilitate the isolation of genes involved in biosynthesis, as well as possible ancillary proteins involved in regulation, sequestration, or the rhizosecretion of allelochemicals. Moreover, the availability of additional molecular probes for specific allelochemical pathways will ultimately shed further light on the modes of regulation and environmental interactions involved, for which there is currently a paucity of information.[70)]

3. NATURAL PRODUCTS USED AS HERBICIDES

3.1 Approaches

Natural products may be used directly as pure compounds or as components of a crude preparation. For example, crude preparations of hydrolyzed maize gluten have been commercialized in the U.S. for weed management in turf.[71)] Other crude preparations, such as olive oil mill wastes[72)] and crambe (*Crambe abyssinia*) seed meal[73)] have been found to provide weed control. Such products require relatively little regulatory approval before they are sold. However, the large volume of most of these products needed for weed control in major crops, their relatively high cost, and the limited availability of the material restricts their use to niche markets that are unlikely to have any impact on synthetic pesticide use.

The other approach to using natural product directly for weed management is to use the pure compound as a herbicide or as a lead compound for the discovery of new herbicides. This strategy has had significant impact in terms of major herbicides and herbicide chemistries based on natural products.

3.2 Discovery strategies

The discovery process for natural product-based herbicides is somewhat different than that for synthetic herbicides. The most obvious difference is that, with the synthetic strategy, the structure of the compound is known, but determining the structure of a natural product found to have good biological activity can be difficult. The synthesis approach involves production of many compounds with doubtful biological activity, whereas, with the natural products approach, relatively few compounds are screened, but the probability of biological activity is much higher. Compounds from the synthetic approach are usually quite simple structurally, as the cost of production must be low for such a product. However, natural products can often be structurally complex, sometimes with multiple chiral centers. In such cases, structure-activity research can sometimes simplify and optimize the herbicidal activity. Unfortunately, the biological activity of a natural product has often been optimized by nature, so that efforts to improve its physicochemical properties or activity at the molecular target site are sometimes unsuccessful.

There are two discovery approaches with natural products. The first of these is to bioassay known natural products that have not been tested for phytoxicity. Relatively few of the natural products reported in the literature have been tested for herbicidal activity. However, most of this type of testing has not been reported. One can randomly test any natural product that can be obtained, or the chemical structure of known compounds can provide clues that suggest the compound might be a phytotoxin. For example, the structure of several natural triketone and triketone-like compounds indicated that they would be good inhibitors of HPPD.[55)] Analogues of plant biosynthetic pathway intermediates are likely candidates as phytotoxins because of the probability that they will be inhibitors of critical enzymes for survival of the weed. For example, 2,4-anhydro-D-glucitol, a metabolite of *Fusarium solani*, is an analogue of fructose. After it is phosphorylated, it is both a phytotoxin and an inhibitor of fructose-1,6-bisphosphate aldolase.[74)] Previous findings of toxicity against organisms other than plants also provide a clue that a compound could be herbicidal. For example, the antimalarial activity of artemisinin was the basis for testing it as a phytotoxin.[75)] Artemisinin and some of its natural product analogues are relatively potent phytotoxins.[76,77)]

Most natural product discovery involves bioassay-directed isolation of compounds of interest. There are hundreds of thousands, if not millions, of potential sources of natural products, few of which have been adequately tested evaluated for phytotoxin production. Considering the amount of work needed for bioassay-directed isolation, a random sampling of organisms may not be the most efficient discovery strategy. The pesticide industry has focused most of its attention on compounds from soil microbes found in exotic locations. Only a small fraction of soil microbes have been cultured,[78)] so this is still a large, virtually untapped resource. However, we know little of how much duplication exists between secondary metabolites from this type of source. Discovery of known compounds in new organisms is a costly problem in bioassay-directed isolation-based discovery schemes,79) and diminishing returns will become a bigger problem as bioprospecting for natural compounds progresses.

However, chemical ecology studies provide clues that might narrow the focus to fewer organisms. Just as ethnobotanical clues have been useful in the discovery of pharmaceutical uses of natural products, chemical ecology information can predict which organisms might generate phytotoxins. Most plant pathogens and all allelopathic plants (including lichens and algae) produce phytotoxins. Examples of potent plant pathogen-produced phytotoxins are tentoxin, cyperin, and AAL-toxin. Several examples of plant pathogen-produced phytotoxins are provided below. Yet, relatively little discovery effort has been focused on plant pathogens as sources of phytotoxins.

Anatomical aspects of higher plants can provide useful clues as to phytotoxin production. Plants often sequester or secrete highly phytotoxic compounds in order to avoid autotoxicity. For example, artemisinin and other phytotoxins are sequestered in non-living parts of glandular trichomes.62) Sorgoleone is produced only by root hair cells and is secreted from the cell as soon as it is produced.53) In both cases, the molecular target site of the producing plant is apparently susceptible to the phytotoxin. We are currently involved in examination of trichome content and root exudates from other plant species.

3.3 Examples

There are only three commercial successes of the commercial use of pure natural compounds as herbicides. The *Streptomyces* spp. phytotoxins phosphinothricin and bialaphos are the only glutamine synthetase-inhibiting herbicides on the market. Phosphinothricin is sold as a chemically synthesized product, glufosinate, while bialaphos is the only herbicide produced by fermentation. These two compounds are the only commercial herbicides that target glutamine synthetase.80) Pelargonic acid (Fig. 4), a naturally occurring fatty acid, is sold for weed control in turf.81) It has a very limited market.

The triketone herbicides were derived from the natural allelochemical, leptospermone (Fig. 4), an allelochemical produced by the bottlebrush shrub (*Callistemon* spp.).82) Sulcotrione (Fig. 4) and other triketone herbicides derived from this source are now marketed. The compounds are phytotoxic by inhibition of HPPD. Other natural products with triketone and benzoquinone structures, such as usnic acid (Fig. 4) and sorgoleone (Fig. 1) are also potent inhibitors of HPPD.56,83)

Cinmethylin (Fig. 4) is a close analogue of the allelochemical, 1,4-cineole (Fig. 4), although there has been no claim that it was derived from this natural phytotoxin. 1,4-cineole is a potent inhibitor of asparagine synthetase (AS),84) a new molecular target site. Cinmethylin has no *in vitro* effects on AS, although it is apparently metabolically converted to a hydroxy-1,4-cineole, which is a potent inhibitor of the enzyme. The more common plant-derived monoterpene, 1,8-cineole has no effect on AS,84) and its phytotoxicity appears to be due to effects on mitosis.85)

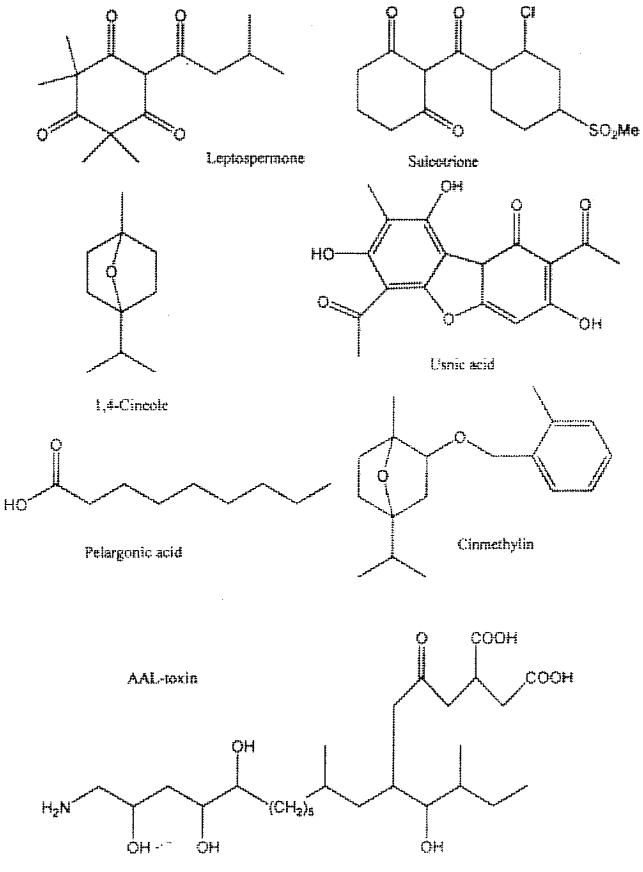


Fig. 4 Structures of some of the natural phytotoxins mentioned in the text.

Certain pathovars of *Alternaria alternata* produce AAL-toxin (Fig. 4), one of the strongest natural phytotoxins,86) although it was originally reported as a host-selective phytotoxin, affecting only certain tomato varieties.87) It is an analogue of the sphingoid base precursors of ceramide synthase, and apparently causes rapid and dramatic accumulation of these compounds in plant tissues by inhibition of this enzyme.88) Treatment of plants with the sphingonine and phytosphingosine, the compounds that accumulate in the presence of AAL-toxin, causes symptoms very similar to those caused by AAL-toxin.89) These results and others have led us to hypothesize that AAL-toxin causes plant death by inhibition of ceramide synthesis, thereby causing massive accumulation of membrane-disrupting sphingoid bases.90)

Indeed, both inhibitors of ceramide synthase and sphinganine cause similar cell death in mammalian cells,[91] although this process is thought to be apoptosis mediated. Unfortunately, AAL-toxin is highly toxic to mammals and structure-activity manipulation has not resulted in producing an analogue with significantly reduced mammalian toxicity, while retaining strong phytotoxicity.[90]

These are only a small fraction of the natural products known to have phytotoxicity sufficient for herbicide use. What little is known of their molecular target sites suggests that they are offer good opportunities for the discovery of new herbicide modes of action.[1]

SUMMARY

In summary, natural products, either as herbicides or as cover crop- or crop-generated allelochemicals, offer important new options for weed management. New technologies and strategies offer to bring these possibilities to fruition in the near future. The process of bioassay-directed isolation has become more automated and faster, thereby alleviating some of the obstacles to natural product-based herbicide discovery strategies. The tools of molecular biology provide a means of generating crops that produce sufficient allelochemicals for weed management with greatly reduced synthetic herbicide input.

REFERENCES

1) S. O. Duke, F. E. Dayan and J. G. Romagni: *Crop Protect.* **19**, 583-589 (2000).
2) S. O. Duke, F. E. Dayan and J. G. Romagni: *Weed Res.* **40**, 99-111 (2000).
3) S. O. Duke, S. R. Baerson, F. E. Dayan, I. A. Kagan, A. Michel and B. E. Scheffler: "Enhancing Biocontrol Agents and Handling Risks," ed. by M. Vurro, J. Gressel, T. Butt, G. E. Harman, A. Pilgeram, R. J. St. Leger and D. L. Nuss, IOS Press, Amsterdam, pp. 96-105, 2001.
4) S. O. Duke, F. E. Dayan, A. M. Rimando, K. K. Schrader, G. Aliotta, A. Oliva and J. G. Romagni: *Weed Sci.* **50**, 138-151 (2002).
5) H. P. Singh, D. R. Batish and R. K. Kohli: *J. Crop Prod.* **4**, 1-41 (2001).
6) L. B. Jensen, B. Courtois, S. Lishuang, L. Zhikang and M. Olofsdotter: *Agron. J.* **93**, 21-26 (2001).
7) H. Wu, H. Pratley, D. Lemerle and T. Haig: *Weed Res.* **39**, 171-180 (1999).
8) J. V. Lovett and A. H. C. Hoult: *Amer. Chem. Soc. Symp. Ser.* **582**, 170-183 (1995).
9) L. Overland: *Amer. J. Bot.* **53**, 423-432 (1966).
10) D. G. Shilling, A. D. Worsham and D. A. Danehower: *Weed Sci.* **34**, 738-744 (1986).
11) D. L. Liu and J. V. Lovett: "Alternatives to the Chemical Control of Weeds," 1990 Proceedings of an International Conference, Rotuora, New Zealand, July, 1989, FRI Bulletin 155, ed. by C. Bassett, L. J. Whitehouse and J. A. Zabkiewicz, Ministry of Forestry, Rotuora, New Zealand, 85-92.
12) J. V. Lovett and A. H. C. Hoult: *Amer. Chem. Soc. Symp. Ser.* **582**, 170-183 (1995).
13) H. Börner: *Bot. Rev.* **26**, 393-424 (1960).
14) A. Baghestani, C. Lemieux, G. D. Leroux, R. Baziramakenga and R. R. Simard: *Weed Sci.* **47**, 498-504 (1999).
15) A. D. Hanson, P. L. Traynor, K. M. Ditz and D. A. Reicosky: *Crop Sci.* **21**, 726-730 (1981).
16) A. H. C. Hoult and J. C. Lovett: *J. Chem. Ecol.* **19**, 2245-2254 (1993).
17) H. Yoshida, H. Tsumuki, K. Kanehisa and L. J. Corcuera: *Phytochemistry* **34**, 1011-1013 (1993).
18) J. V. Lovett , A. H. C. Hoult and O. Christen: *J. Chem. Ecol.* **20**, 1945-1954 (1994).
19) D. L. Liu and J. V. Lovett: *J. Chem. Ecol.* **19**, 2231-2244 (1993).
20) D. L. Liu and J. V. Lovett: *J. Chem. Ecol.* **19**, 2217-2230 (1993).
21) V. Kat and R. J. Froud-Williams: *1999 Brighton Crop Protection Conference-Weeds* **2**, 579-580 (1999).
22) B. N. Barria, S. V. Copaja and H. M. Niemeyer: *Phytochemistry* **31**, 89-91 (1992).
23) G. G. Nagabhushana, A. D. Worsham and J. P. Yenish: *Allelopathy J.* **8**, 133-146 (2001).
24) Y. Fujii: *J. Crop Prod.* **4**, 257-275 (2001).
25) J. P. Barnes and A. R. Putnam: *J. Chem. Ecol.* **9**, 1045-1057 (1993).
26) F. J. Pérez and J. Ormeño-Nuñez: *J. Chem. Ecol.* **17**, 1037-1043 (1991).
27) F. J. Pérez and J. Ormeño-Nuñez: *Weed Res.* **33**, 115-119 (1993).
28) M. Pethő: *Acta Agron. Hung.* **41**, 167-175 (1992).
29) J. P. Barnes and A. R. Putnam: *J. Chem. Ecol.* **13**, 889-906 (1987).
30) R. W. Gagliardo and W. S. Chilton: *J. Chem. Ecol.* **18**, 1683-1691 (1992).
31) A. Friebe, I. Wieland and M. Schulz: *Angew. Bot.* **70**, 150-154 (1996).
32) J. P. Barnes and A. R. Putnam: *Weed Sci.* **34**, 384-390 (1986).
33) R. H. Dilday, P. Nastasi and R. J. Smith: "Sustainable Agriculture for the Great Plains," Symposium Proceedings, USDA, ARS, ARS-89, ed. by J. D. Hanson, M. J. Shaffer, D. A. Ball and C. V. Cole, USDA, ARS, Beltsville, MD, pp. 193-201, 1991.
34) K. U. Kim and D. H. Shin: "Allelopathy in Rice," ed. by M. Olofsdotter, International Rice Research Institute, Manila, Philippines, pp. 39-43, 1998.
35) M. Olofsdotter, D. Wang and D. Navarez: "Recent Advances in Allelopathy, Vol. I, A Science for the Future," ed. by F. A. Macias, J. C. G. Galindo, J. M. G. Molinillo and H. G. Cutler, Servicio de Publicaciones - Universidad de Cadiz, Spain, pp. 383-390, 1999.
36) Y. Fujii: *Proc. Plant Growth Regul. Soc.* **22**, 14-18 (1995).
37) D. Navarez and M. Olofsdotter: Proc. 2nd Internal Weed Control Conf., Copenhagen, Denmark, **4**, 1285-1290 (1996).
38) R. Mattice, T. Lavy, D. Skulman and R. Dilday: "Allelopathy in Rice," ed. by M. Olofsdotter, International Rice Research Institute, Manila, Philippines, pp. 81-98, 1998.
39) K. W. Kim and K. U. Kim: "Proc. International Workshop on Rice Allelopathy," Institute of Agricultural Science and

Technology, Kyungpook National University, Tageu, Korea, pp. 73–84, 1998.

40) I. M. Chung, J. K. Ahn and S. J. Yun: *Can. J. Plant Sci.* **81**, 815–819 (2001).

41) W. Lin, H. He, Y. Guo, Y. Liang and F. Chen: *Yingyong Shengtai Xuebao* **12**, 871–875 (2001).

42) A. M. Rimando, M. Olofsdotter, F. E. Dayan and S. O. Duke: *Agron. J.* **93**, 16–20 (2001).

43) T. Kato, M. Tsunakawa, N. Sasaki, H. Aizawa, K. Fujita, Y. Kitahara and N. Takahashi: *Phytochemistry* **16**, 45–48 (1977).

44) M. Olofsdotter, M. Rebulanan, A. Madrid, W. Dali, D. Navarez and D. C. Olk: *J. Chem. Ecol.* **28**, 229–242 (2002).

45) C. Kong, X. Xu, F. Hu, X. Chen, B. Ling and Z. Tan: *Chin. Sci. Bull.* **47**, 839–843 (2002).

46) T. Kato, C. Kabuto, N. Sasaki, M. Tsunagawa, H. Aizawa, K. Fujita, Y. Kato and Y. Kitahara: *Tetrahedron Lett.* **39**, 3861–3864 (1973).

47) M. Tsunakawa, A. Ohba, N. Sasaki, C. Kabuto, T. Kato, Y. Kitahara and N. Takahashi: *Chem. Lett.* **11**, 1157–1158 (1976).

48) C. W. Lee, K. Yoneyama, M. Ogasawara, Y. Takeuchi and M. Konnai: Proc. 17th Asian-Pacific Weed Science Society Conference, Bangkok, Thailand, Nov. 22–27 (1999).

49) H. Kato-Noguchi: *Plant Prod. Sci.* **5**, 8–10 (2002).

50) L. A. Weston, C. I. Nimbal and J. Jeandet: "Principles and Practices in Plant Ecology, Allelochemical Interactions," ed. by Inderjit, K. M. M. Dakshini and C. L. Foy, CRC Press, Boca Raton, Florida, pp. 467–477, 1999.

51) A. M. Rimando, F. E. Dayan, M. A. Czarnota, L. A. Weston, S. O. Duke: *J. Nat. Prod.* **61**, 927–930 (1998).

52) M. A. Czarnota, R. N. Paul, F. E. Dayan, C. I. Nimbal and L. A. Weston: *Weed Technol.* **15**, 813–825 (2001).

53) F. A. Einhellig, J. A. Rasmussen, A. M. Hejl and I. F. Souza: *J. Chem. Ecol.* **19**, 369–375 (1993).

54) J. C. Streibig, F. E. Dayan, A. M. Rimando and S. O. Duke: *Pestic. Sci.* **55**, 137–146 (1999).

55) G. Meazza, B. E. Scheffler, M. R. Tellez, A. M. Rimando, J. G. Romagni, S. O. Duke, D. Nanayakkara, I. A. Khan, E. A. Abourashed, F. E. Dayan: *Phytochemistry* **59**, 282–288 (2002).

56) S. O. Duke, B. E. Scheffler, F. E. Dayan and E. Ota: *Weed Technol.* **15**, 826–834 (2001).

57) S. O. Duke, B. E. Scheffler, F. E. Dayan and W. E. Dyer: *Amer. Chem. Soc. Symp. Ser.* **829**, in press (2002).

58) B. E. Scheffler, S. O. Duke, F. E. Dayan and E. Ota: *Rec. Adv. Phytochem.* **35**, 257–274 (2000).

59) M. Frey, P. Chomet, E. Glawischnig, C. Stettner, S. Grün, A. Winklmair, W. Eisenreich, A. Bacher, R. B. Meeley, S. P. Briggs, K. Simcox and A. Gierl: *Science* **277**, 696–699 (1997).

60) R. H. Hamilton: *Weeds* **12**, 27–30 (1964).

61) L. Diatchenko, Y.-F. C. Lau, A. P. Campbell, A. Chenchik, F. Moquadam, B. Huang, S. Lukyanov, K. Lukyanov and N. Gurskaya: *Proc. Natl. Acad. Sci. USA* **93**, 6025–6030 (1996).

62) P. Liang and A. B. Pardee: *Science* **257**, 967–971 (1992).

63) M. V. Duke, R. N. Paul, H. K. ElSohly, G. Sturtz and S. O. Duke: *J. Plant Sci.* **155**, 365–373 (1994).

64) M. R. Tellez, C. Canel, A. M. Rimando and S. O. Duke: *Phytochemistry* **52**, 1035–1040 (1999).

65) M. D. Adams, J. M. Kelley, J. D. Gocayne, M. Dubnick, M. H. Polymeropoulos, H. Xiao, C. R. Merril, A. Wu, B. Olde and R. F. Moreno: *Science* **252**, 1651–1656 (1991).

66) B. M. Lange, M. R. Wildung, E. J. Stauber, C. Sanchez, D. Pouchnik and R. Croteau: *Proc. Natl. Acad. Sci. USA* **97**, 2934–2939 (2000).

67) D. H. Netzley and L. G. Butler: *Crop Sci.* **26**, 776–778 (1986).

68) M. Hiratsuka, Y. Kishikawa, K. Narahara, T. Inoue, S. I. Hamdy, Y. Agatsuma, Y. Tomioka and M. Mizugaki: *Anal. Biochem.* **289**, 300–303 (2001).

69) M. Bucher, B. Schroeer, L. Willmitzer and J. W. Riesmeier: *Plant Mol. Biol.* **35**, 497–508 (1997).

70) F. A. Einhellig: *Amer. Chem. Soc. Symp. Ser.* **582**, 1–24 (1995).

71) R. E. Gough and R. Carlstrom: *HortScience* **34**, 269–270 (1999).

72) G. Aliotta, G. Cafiero, V. De Feo, B. Di Blasio, R. Iacovino and A. Oliva: *Curr. Top. Phytochem.* **3**, 167–177 (2000).

73) S. F. Vaughn and M. A. Berhow: *J. Chem. Ecol.* **24**, 1117–1126 (1998).

74) F. E. Dayan, A. M. Rimando, M. R. Tellez, B. E. Scheffler, T. Roy, H. K. Abbas and S. O. Duke: *Z. Naturforsch.* in press (2002).

75) S. O. Duke, K. C. Vaughn, E. M. Croom, Jr. and H. N. Elsohly: *Weed Sci.* **35**, 499–505 (1987).

76) S. O. Duke, R. N. Paul and S. M. Lee: *Amer. Chem. Soc. Symp. Ser.* **380**, 318–334 (1988).

77) F. E. Dayan, A. Hernandez, S. N. Allen, R. M. Moraes, J. A. Vroman, M. A. Avery and S. O. Duke: *Phytochemistry* **50**, 607–614 (1999).

78) A. Felske, H. Rheims, A. Wolternick, E. Stackebrandt and A. D. Akkermans: *Microbiology* **143**, 2983–2989 (1997).

79) S. W. Ayer, B. G. Ksaac, D. M. Krupa, K. E. Crosby, L. J. Letendre and R. J. Stonard: *Pestic. Sci.* **27**, 221–223 (1989).

80) J. Lydon and S. O. Duke: "Plant Amino Acids, Biochemistry and Biotechnology," ed. by B. K. Singh, New York, pp. 445–464, 1999.

81) G. P. Irzyk, P. Zorner and A. Kern: *Weed Sci. Soc. Amer. Abstr.* **37**, 103 (1997).

82) D. L. Lee, M. P. Prisbylla, T. H. Cromartie, D. P. Dagarin, S. E. Howard, W. M. Provan, M. K. Ellis, T. Fraser and L. C. Mutter: *Weed Sci.* **45**, 601–609 (1997).

83) J. G. Romagni, G. Meazza, N. P. D. Nanyakkara and F. E. Dayan: *FEBS Lett.* **480**, 301–305 (2000).

84) J. G. Romagni, S. O. Duke and F. E. Dayan: *Plant Physiol.* **123**, 725–732 (2000).

85) J. G. Romagni, S. N. Allen and F. E. Dayan: *J. Chem. Ecol.* **26**, 303–313 (2000).

86) H. K. Abbas, T. Tanaka, S. O. Duke and C. D. Boyette: *Weed Technol.* **9**, 125–130 (1995).

87) S. D. Clouse and D. C. Gilchrist: *Phytopathology* **77**, 80–82 (1987).

88) H. K. Abbas, T. Tanaka, S. O. Duke, J. K. Porter, E. M. Wray, L. Hodges, A. E. Sessions, E. Wang, A. H. Merrill and R. T. Riley: *Plant Physiol.* **106**, 1085–1093 (1994).

89) T. Tanaka, H. K. Abbas and S. O. Duke: *Phytochemistry* **33**, 779–785 (1993).

90) H. K. Abbas, S. O. Duke, W. T. Shier and M. V. Duke: "Advances in Microbial Toxin Research and Its Biotechnological Exploitation," ed. by R. K. Upadhyay, Kluwer Academic/Plenum Publ., London, pp. 211–229, 2002.

91) E. H. Ahn and J. J. Schroeder : *Exp. Biol. Med.* **227**, 345–353 (2002).

2.2.1.2 Nicotine. Nicotine (**16**; Fig 3) is a major component within the Genus *Nicotiana*, and particularly the species *Nicotiana rustica* L. It is a non-systemic insecticide that binds to the cholinergic acetylcholine nicotinic receptor in the nerve cells of insects, leading to a continuous firing of the neuroreceptor.[39] Active predominantly through the vapour phase, but also with slight contact and stomach action, nicotine has been used for many years as a fumigant for the control of many sucking insects. It can be used to give partial control of organophosphorus- and pyrethroid-resistant whitefly.[40] The compound is used as a foliar spray to cover the undersides of leaves, repeating the application as necessary. Best results are achieved when the ambient temperature is $>16\,°C$; this temperature is essential if the compound is used as a fumigant. Nicotine is sold as dispersible powder (DP), soluble concentrate (SL) or as fumigant formulations under a number of trade names including Nico Soap (United Phosphorus Ltd), No-Fid (Hortichem), XL-All Nicotine (Vitax) and Nicotine 40% Shreds (Dow AgroSciences). The compound is acutely toxic to mammals and other non-target organisms, with an acute oral LD_{50} to rats of $50–60\,mg\,kg^{-1}$.

2.2.1.3 Plant pelargonic and related fatty acids. Pelargonic acid (**17**; Fig 3) and related fatty acids are naturally occurring acids from both plant and animal sources. Fatty acid extracts interfere with the cell membrane constituents of the target organism, leading to a breakdown of the integrity of the membrane and death. Different fatty acids are effective as insecticides, fungicides, total herbicides or as moss killers. The insecticidal uses of pelargonic acid include control of many different insect species in vegetables, fruit and ornamentals; fungicidal uses include disease control in grapes, roses and other crops and herbicide uses include total weed control and moss control in lawns. It is applied as a foliar spray to crops, ensuring good coverage of the target pest.

Natural fatty acids are sold by Mycogen as liquid concentrate (SL) formulations. M-Pede is used for controlling soft bodied insects such as aphids, and for curative control of powdery mildew pathogens; Scythe is an effective total, non-residual herbicide; De-Moss controls moss in lawns and mosses and liverworts on fences, roofs and glasshouses; and Thinex is used as a fruit thinning agent. Akzo-Nobel also market the product Neo-Fat. Pelargonic acid and related fatty acids are generally considered to be non-toxic.

2.2.1.4 Pyrethrins. The dried, powdered flower of *Chrysanthemum cinerariaefolium* Vis has been used as an insecticide from ancient times. Recent taxonomic revisions have transferred this species from the genus *Chrysanthemum* to the genus *Tanacetum* but it is still often recorded as *Pyrethrum*. The species was identified in antiquity in China and it spread West via Iran (Persia) probably via the Silk Routes in the Middle Ages. The dried, powdered flower heads were known as 'Persian Insect Powder'. Records of use date from the early 19th century when it was introduced to the Adriatic coastal regions of Yugoslavia (Dalmatia) and some parts of the Caucasus. Subsequently, it was grown in France, the USA and Japan. It is now widely grown in East African countries, especially Kenya, in Ecuador, Papua New Guinea and Australia.

Pyrethrins (**18**; Fig 3) have been shown to bind to the sodium channels in insects, prolonging their opening and thereby causing knockdown and death. They are non-systemic insecticides with contact action. Initial effects include paralysis, with death occurring later. They have some acaricidal activity.[41–43]

The product is normally applied in combination with synergists, eg piperonyl butoxide, that inhibit detoxification. Good cover of crop foliage is essential for effective control, although field persistence is poor because of the compounds' photo-instability. Many combination products with other insecticides are available. There are a large number of products formulated as aerosol dispensers (AE), dispersible powders (DP), emulsifiable concentrates (EC), fogging concentrates, wettable powders (WP) and ultra-low-volume liquids (UL) under trade names that include Alfadex (Novartis), Pyrocide and Evergreen (MGK), Pyronyl (mixture), ExciteR and Prentox Pyrethrum Extract (all Prentiss), Milon (Delicia), Pycon (for concentrated mixture with piperonyl butoxide) (Agropharm) and CheckOut (Consep).

Pyrethrins are considered to be relatively low toxicity compounds, with acute oral LD_{50} to rats of $>2000\,mg\,kg^{-1}$.

2.2.1.5 Rotenone. Rotenone (**19**; Fig 3) and related rotenoids were originally used in Asia and South America as fish poisons, being obtained from *Derris*, *Lonchocarpus* and *Tephrosia* species. Rotenone is an inhibitor of Site I respiration within the electron transport chain and is used as a selective, non-systemic insecticide with contact and stomach action, with secondary acaricidal activity.[44,45] It is applied as an overall spray to give good cover of the foliage and is often used as a component of mixtures. It can be used in organic farming systems in extreme conditions of insect attack. The product is sold as dispersible powder (DP), emulsifiable concentrate (EC) and wettable powder (WP) formulations with trade names that include Chem Sect, Cube Root and Rotenone Extract (all Tifa), Noxfire and Rotenone FK-11 (AgrEvo Environmental Health) and Prenfish (mixture), Prentiss, Synpren Fish (mixture) and Prentox (all Prentiss). Rotenone is considered to be a toxic compound with an acute oral LD_{50} to rats of $132\,mg\,kg^{-1}$; it is very toxic to fish.

2.2.1.6 Ryania extracts. Collaborative work between Rutgers University and Merck in the early 1940s followed the lead from the use of *Ryania* species in South America for euthanasia and as rat poisons and

The following information was generated from the
Hazardous Substances Data Bank (HSDB),
a database of the National Library of Medicine's TOXNET system
(http://toxnet.nlm.nih.gov) on February 2, 2005.

Query: The chemical name was identified.
The following terms were added from ChemIDplus:
nonanoic acid
pelargic acid
CAS Registry Number: 112-05-0

1
NAME: NONANOIC ACID

RN: 112-05-0

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:
Portions of the POISINDEX(R) and MEDITEXT(R) database have been provided here for general reference. THE COMPLETE POISINDEX(R) DATABASE OR MEDITEXT(R)

```
DATABASE SHOULD BE CONSULTED FOR ASSISTANCE IN THE DIAGNOSIS OR TREATMENT OF
SPECIFIC CASES. The use of the POISINDEX(R) and MEDITEXT(R) databases is at your
sole risk. The POISINDEX(R) and MEDITEXT(R) databases are provided "AS IS" and
"as available" for use, without warranties of any kind, either expressed or
implied. Micromedex makes no representation or warranty as to the accuracy,
reliability, timeliness, usefulness or completeness of any of the information
contained in the POISINDEX(R) and MEDITEXT(R) databases. ALL IMPLIED WARRANTIES
OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE OR USE ARE HEREBY
EXCLUDED. Micromedex does not assume any responsibility or risk for your use of
the POISINDEX(R) or MEDITEXT(R) databases. Copyright 1974-2004 Thomson
MICROMEDEX. All Rights Reserved. Any duplication, replication, "downloading,"
sale, redistribution or other use for commercial purposes is a violation of
Micromedex' rights and is strictly prohibited.<p>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.

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**

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 [SRI, p.]**PEER REVIEWED**

CHEM INT FOR SPECIALTY DIESTERS-EG, WITH PROPYLENE GLYCOL [SRI, p.]**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) [SRI, p.]**PEER REVIEWED**

(1981) PROBABLY GREATER THAN 6.81X10+6 GRAMS [SRI, p.]**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**

SYNONYMS AND IDENTIFIERS:

SYNONYMS:

CIRRASOL 185A [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry of Toxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file., p. 82/8105]**PEER REVIEWED**

EMFAC 1202 [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry of Toxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file., p. 82/8105]**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 [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**

PELARGIC ACID **PEER REVIEWED**

PELARGONIC ACID **PEER REVIEWED**

PELARGON (RUSSIAN) [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry of Toxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file., p. 82/8105]**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**

Appendix F

www.CaliforniaFarmer.com

CORN STUNT RERUN / 12 • MELON MASTER / 54 • WHAT SHAPES WINE PRICES? / 44

CALIFORNIA FARMER

A FARM PROGRESS PUBLICATION • SEPTEMBER 2003

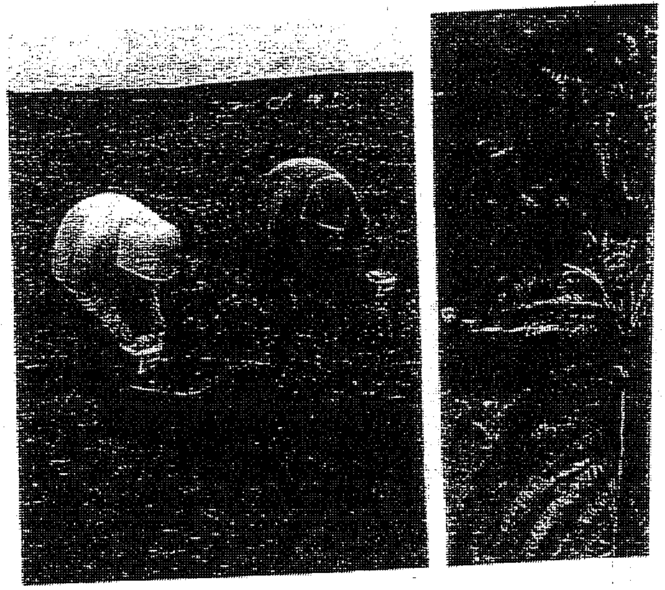
Organic profits

It takes Bug Vacs and trap crops to protect organic berries. See page 10.

COVER STORY

Mining organic gold

The thorny part of going organic is finding land to grow the gold. ■ *By Brenda Carol*



When the markets get tough, sometimes the only choice is to get tougher. That's the strategy Pacific Gold Farms Inc. adopted, and it's given them an edge in the highly competitive world of fresh produce marketing. Pacific Gold Farms is a year-round grower-shipper of fresh California strawberries, and they also grow blackberries, raspberries, bell peppers and green beans. Their growing operations span California's coastline from Orange County to Watsonville and spill over into the Coachella Valley for year-round production capability.

While the company prides itself on all of its produce, the venture into organic strawberry production is of particular interest.

"We're very excited about the organic portion of our business," says Larry Eddings, president of Pacific Gold Farms. Eddings supervises all of the growing operations while his partner, Peter Orr, serves as the chairman and CEO.

"The demand for organic has been stronger than we ever imagined," Eddings says. "If I had known that five years ago, I would have put every acre I could into organic production."

As it stands today, Pacific Gold has 45 acres of organic strawberries scattered throughout its growing operations. Eddings plans to increase that to 100 acres as quickly as possible.

"One of the biggest challenges in organic production is simply finding the ground," he says. "We prefer to start with ground that is certified organic or find ground that hasn't been farmed. Otherwise, you have to go through a three-year certification program before you can market the crop as organic. That's a lot of time to invest before getting the full return."

FARMING VS. SPRAWL

Finding any farmland is getting tougher in California as urban encroachment becomes more invasive into the rural landscape. "In Orange County, it's particularly tight," Eddings says. "A lot of our land is leased, so we're often at the mercy of the landlord and often that landlord is usually eying the development potential of the property."

One example of that risk and how much it entails is a piece of ground that Eddings farms just north of Salinas. Pacific Gold leased the 200-acre property because it had never been farmed and therefore was well suited for organic production. The property is situated on rolling hills, so it required major renovations just to comply with a myriad of environmental codes and regulations.

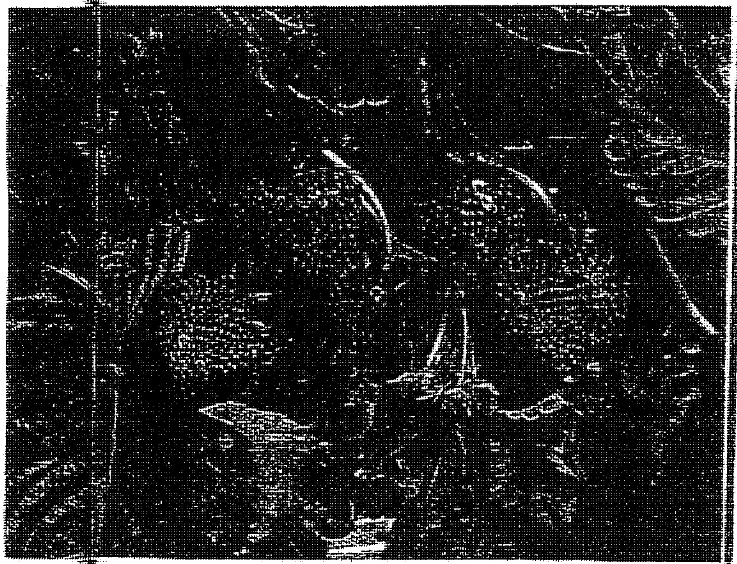
"There are 11 engineered cache basins on that 200 acres," Eddings says. "We sank a lot of money into that piece of property, and it took us a year to bring it into production. Almost everywhere you stand out there, you can look around at the neighboring hills and see houses. The property has already been designated for development. The only question is when."

In addition to the challenge of finding and retaining ground for organic production, producing strawberries in an organic system is equally as challenging. With no methyl bromide or conventional fungicides or any other standard pesticide used in mainstream agriculture, battling disease and pests requires a lot of creativity and a deep understanding of the complex interactions between nature and a strawberry crop.

"You can't just jump into organic farming and be successful at it," Eddings says. "I believe you have to be a good conventional farmer before you tackle organic because you need to bring all of that knowledge to the organic side of things to make it work. By the same token, a lot of the things that we've learned on the organic side have helped us on the conventional side."

As with conventional strawberry production, disease pressure in organic strawberries is a major challenge. There are a few products that Eddings can use — including sulfur and a formulation of baking soda — but cultural practices are the first line of defense.

"One of the first things that we learned is to grow the plants smaller so that you get better air movement through the canopy," he says. "Fungal problems in both conventional and organic production are worse when you have large plants that reduce air movement. We're actually reducing our plant size in our conventional production based on what we've seen in the organic."



Organic sales to climb

Retail sales in the United States are expected to top $20 billion by 2005, up from just $1 billion in 1990. Organic food sales have grown 20% per year during the past ten years, compared to 1% per year for the conventional food industry. The organic food area, as compared to conventional foods, is about 3% of total food sales. Only 0.3% of all U.S. agricultural land is certified as organic compared with 3.24% in the European Union and over 2% in Australia. ◆

TRAP CROPS AND BUG VACS

The use of trap crops is a good example. Eddings began experimenting with various combinations of trap crops in his organic fields. By interspersing rows of trap crops throughout the field, insects are attracted to the trap crop rather than the strawberries — at least theoretically.

"The jury is still out on a lot of these ideas," Eddings says. "It seems to work fairly well. We use a Bug Vac to suck up the pests. We use it on the entire field, but we use it more often just on the trap crop because that's where we get 70 to 80% of the insect pressure."

There are a few products, such as *Bt* sprays that Eddings can use to control worm pests. "But mostly it's a matter of just gritting your teeth and bearing it," he says.

Another major issue in organic production is weed control. Extensive hand labor is required to keep pressure under control throughout the season, and it's one of the inputs that is the most costly in organic production, according to Eddings.

"We do everything we can to minimize hand weeding," he says. "We pre-irrigate and cultivate. We rotate the ground — typically to wheat because it suppresses broadleaves that are our biggest weed problem. In spite of all that, it still requires a lot of hand labor to control weeds."

The learning curve in organic production is steep, and Pacific Gold invests a considerable amount of resources into it. They work closely with the University of California's Sustainable Agriculture Research and Education Program.

"Dr. Sean Swezey and his group have been a valuable asset," Eddings says. "They use our ground to carry out a lot of research trials, and we give them free rein. We've implemented a lot of their data on a very large scale, and it's been very beneficial to us."

MARKETING DEMANDS

Marketing organic strawberries also comes with its unique set of challenges. Consumers who purchase organic products tend to be much more discerning, according to Cindy Jewell, director of marketing for Pacific Gold. "They like smaller, redder berries, and they insist on more flavor," she says. "They don't mind paying more for it, but they demand quality."

Another marketing challenge is availability of product. "We have that same challenge in our conventional berries," Jewell says. "Retailers want a steady, dependable supply of high-quality product. We can provide that in our conventional berries because of the acreage that we farm and the locations we have throughout the state. We're getting closer in our organic berries, but we're not quite there yet. It's very important in today's competitive environment that you put yourself in the position of being a year-round supplier."

One of the most interesting new markets for both conventional and organic berries is processed foods — particularly the dried cereal market. "There's a tremendous demand for processed berries in cereal," Eddings says. "That's something we're really excited about."

With so many sad stories in agriculture today, it's nice to know there is still a little excitement out there for those who are tough enough. ◆

—Carol is a writer living in Carmel.

From: Joe Valdez [Joe@pacificgoldfarms.com]
Sent: Monday, August 16, 2004 3:59 PM
To: Morton, Dwain (DE)
Subject: Organic herbicide

Dwain Morton

Pacific Gold Farms grows just under 100 acres of organic strawberries in Monterey and Ventura Counties. One of the biggest expenses is hand weeding. We use black mulch, but weed pressure is very high. Any material that can be formulated to comply to OMRI standards would be supported by Pacific Gold.

Thank you

Joseph Valdez
PCA, CCA
Pacific Gold Farms

Morton, Dwain (DE)

From: Pebble_Smith@B-F.com
Sent: Tuesday, August 26, 2003 1:51 PM
To: Morton, Dwain (DE)
Subject: Scythe

Hi Dwain ,
This Email is a followup to our phone converstaion of a few days ago . As I said I finally had a chance to evaluate the sample of Scythe that you had left with me both on it's own and as an adjuvant with glyphosphate . Since it was well into summer there were no grasses present but a good mix of legumes such as Birdsfoot trefoil , Black-Medic and Spanish Lotus . Also our favorite nemesis Starthistle , sowthistle and Perenial Mustard . Used by itself at maximum strength it quickly burn't down all of the above except for the mustard which resisted . It's effect on the legumes was very impressive because they were growing in mats under the drip spots and were quite healthy.......they burned right to the ground . With glyphos the results were equally good . We used a low dose of Glyphos and got a quick kill on all the above weeds .

As you know my interest in Scythe is because I am the Grower Rep for one of Californias biggest wineries , Fetzer , and we just recently made a commitment , which we publically stated , to be buying or growing all of the wineries grapes organically by 2010 . This would be over 10,000 acres just for our needs . Pusuant to this commitment we just gave a three day course to our growers on the challenges of Organic farming and there was a unanimous belief that the biggest challenge was weeds , especially those in the vine row that we used to use conventional herbicides on . All that was available was acetic acid and clove oil and they were both expensive , stinky , and not very effective . If you could get OMRI approval for Scythe and deliver it to the grower at a good price I thinkyou could own this category .

I really think that " organics " could be a good niche market not only for an enviromentally committed winery but also for a large chemical company like DOW but alas I can only really speak to the winery part where I can assure you of our intentions . Thanks again for the opportunity to look at your product and I hope to have saved enough to see how it does on the grasses of next season .

James "Pebble" Smith D.V.M.
2720 willow Ceek Rd .
Paso Robles , Ca 93446

Morton, Dwain (DE)

From:	Steven Fennimore [safennimore@ucdavis.edu]
Sent:	Wednesday, August 11, 2004 9:37 AM
To:	Morton, Dwain (DE)
Subject:	Scythe

Hi Dwain

I evaluated Scythe herbicide at 3 to 5% v/v applied at 75 GPA as per label instructions. We applied Scythe in a population of shepherdspurse (3-6 leaf) and redroot pigweed (4-6 leaf). Scythe shepherds purse and pigweed control was 70 to 80% at 6 weeks after application. In organic production systems tillage and propane are the current methods of weed removal on stale seedbeds. There is need for an effective organic- approved herbicide such as Scythe. Propane costs and hazards (fire, operator burns ect) make the use of a sprayable product such as Scythe attractive. There are other potential uses of Scythe in organic production systems such as directed sprays in vegetables and strawberry (weed control in row middles). If there is the opportunity for Dow to pursue OMRI approval for Scythe, I urge you to do so. Sincerely, Steve Fennimore Extension Specialist University of California, Davis 1636 East Alisal St Salinas, CA 93905 831-755-2896

From: Richard Smith [rifsmith@ucdavis.edu]
Sent: Friday, August 13, 2004 4:25 PM
To: Morton, Dwain (DE)
Subject: Scythe

04MontereyCounty
OrganicValue.x...

Dwaine: I am writing this email in support of an organic labeling for Scythe herbicide. This material would be of great benefit to the growing organic industry in Monterey County (See attached data). Nearly every large vegetable production company in the Salinas Valley has an organic component to their operation. Scythe would be useful for general weed control programs, cleaning out furrow bottoms, stale seed beds, etc. The use of Scythe would probably be substantial given the increased interest in organic horticulture, but also for non crop uses around schools, etc. Richard.

Richard Smith
Vegetable Crop and Weed Science Farm Advisor
University of California Cooperative Extension
Monterey, Santa Cruz and San Benito Counties
1432 Abbott Street, Salinas, CA 93901
831-759-7350; fax 831-758-3018; rifsmith@ucdavis.edu http://cemonterey.ucdavis.edu/

Value of organic agriculture in Monterey County - Source Monterey County Agricultural Commissioner

Year	Value (in 1000 of dollars)
1991	9115
1992	9650
1993	10879
1994	11515
1995	11675
1996	20722
1997	23610
1998	45849
1999	72652
2000	89853
2001	108045
2002	119689
2003	128252

TANIMURA AND ANTLE

P.O. BOX 4070
SALINAS, CA 93908

Dr. Gary Thompson
Global Technical Expert for
Spinosid and Mac Chemistry
Dow AgroSciences
9330 Zionsville Road
Indianapolis, IN 46268-1054

Dear Dr. Thompson

Our Dow AgroSciences representative, Dwain Morton, has told us about an exciting product called Scythe-L. We have met with him and gone over the label. He has also told us that it is your desire to get Scythe-L Certified Organic. We truly believe this product would have a large use on our organic acres. We currently have 1,200 acres certified Organic. This market is growing and as market demand increases, we will commit more acres to organic production. Please feel free to use this letter in any way that will help get Scythe-L certified Organic. At this time, the organic grower has **very few options on herbicides that can be used.** There are some acids that can be used, but they are not very effective. As you can imagine, hand labor is very expensive along with the liability that goes with it.

Please do everything in your power to move this product over to the Organic Label. If I can be of further assistance, please contact Dwain, or call or e-mail me at the following numbers:

Sergio Casillas
Tanimura and Antle
Cell – 805-229-7257
E-mail – sergioc@taprodce.com

APPLIED
AGRICULTURAL
TECHNOLOGIES

MONTEREY PACIFIC

40410 ARROYO SECO RD.
SOLEDAD, CA 93960
TEL – 408-678-4845
FAX – 408-678-4846

June 17, 2004

To Whom It May Concern:

I would like to comment on the possible registration and subsequent use of the herbicide known by the trade name of Scythe manufactured by Dow Agrosciences. This material would be a very important new tool for the organic farming industry.

Weed control is the most cost prohibitive part of organic farming. I manage 200 acres of organic wine grapes for a vineyard management company in Greenfield California. At the present time there are no organic herbicides registered in California that are effective, safe and affordable.

Scythe is a very good contact herbicide that is safe to work with and effective. It would be used extensively if it was registered with an organic label.

Weed control using mechanical tools eventually leads to soil compaction forming hard pans at low depths below the grape vines. The hard pans once formed can never be broken up because of the narrow row spacing between the vines. The only other alternative is hand hoeing.

I've worked with scythe extensively in the greenhouse industry and it is a very good herbicide. Please give it an organic label.

Thank You,

Berny Borges

Berny Borges
Monterey Pacific, Inc.

Mission
Organics

Dwain Morton, PCA/CCA
Sales Representative, Coastal States
Dow AgroSciences LLC
2376 Willet Way
Arroya Grande, CA 93420

Dear Mr. Morton,

I am writing this letter to encourage Dow AgroSciences to obtain organic registration of the herbicide Scythe. I am writing this letter on behalf of Mission Organics, a company that organically farms the majority of the lettuce and leafy vegetables for Earthbound Farms. Mission Organics farms over 5500 acres of organic produce per year. If Scythe was registered for use in organic production, we would potentially use it on 3000 acres of farmland as well as on roadsides and ditch banks around all of our fields.

Organic growers presently do not have an herbicide that is as effective and economical as Scythe. It would be a large improvement to our weed management program to be able to use the herbicide Scythe in organic crop production.

Sincerely,

Ramy Colfer

Ramy Colfer, Ph.D.
Pest Management Research
Mission Organics/ Earthbound Farms
P.O. box 2357
Salinas, CA 93902
mobile (831) 206-5609
office (831) 623-2012
fax (831) 623-2019
email: ramy@ebfarms.com

Green Valley Farm Supply, Inc.
PINNACLE APPLICATION INCORPORATED
Kennedy Farm Services, Inc.

April 22, 2004

Dwain Morton
Dow Agro Sciences
2376 Willet Way
Arroyo Grande, Ca. 93420

Dear Dwain,

Our company conducts full service pest control on approximately 4,000 ground acres of organically farmed vegetables. There are on average 2 crops per year on this ground. Weed control on this ground is a serious issue for the growers. Cinnamin oil is available, but its effectiveness is poor. Flaming is often used, but on a limited basis based on both cost and danger to the applicators. Sythe Herbicide has the potential to have a significant impact if approved by OMRI. It offers a product that works, while offering growers some cost savings in a tight hand labor market. With more trial work we feel it can even have a fit in our conventional program.

Regards,

Mike Kennedy

10 Gonzales River Rd. • P.O. Box 950 • Gonzales, CA 93926
Office: (831) 675-0168 • Fax: (831) 675-3829

Del Conte Ag. Care Inc
Walt Del Conte
195 Aromas Rd.
Aromas, Ca
(831)-726-7209
(831)- 970-6205

10 March 2004

Dwain Morton
Dow Agro Science
2376 Willet Way
Arroyo Grande, CA
93420

Good Morning Dwain:

I was looking at Dow's label for Scythe, and I see it is registered for use on strawberry and caneberry for both weed control as well as chemical pruning. In organic berries we do not have a material that is registered for weed control or chemical pruning.

In caneberries the present practice is to use Gramoxone, a restricted herbicide for chemical pruning. I would like to see if Scythe could be granted organic status by OMI and CCOF. It would make a very useful tool for the berry growers.

There is a need for a broad spectrum herbicide to be used for weed control in both organic strawberry and caneberry.

Thank you,

Walt Del Conte

Walt Del Conte

Plant Sciences, Inc.
Agricultural Consulting, Research, and Production

August 14, 2004

Dwain Morton
Dow AgroSciences
2376 Willet Way
Arroyo Grande, CA 93420

Dear Dwain,

Thank you for the recent opportunity to evaluate the effects of Scythe for general weed control. I was very impressed with its knockdown capabilities on a variety of weed species. I feel that the product could be a very valuable tool for the California strawberry industry (both conventional and organic sectors), particularly now that methyl bromide is being phased out. With conventionally grown strawberries, one of the primary benefits to annual soil fumigation with methyl bromide has been weed control. Now that we're shifting to the alternatives, the need for additional herbicide products for weed control in both the bedded soil and the furrows is apparent. With organically grown berries, the only method of weed control currently available is the use of colored mulches and hand weeding. An effective herbicide compound that could be used in these organic production systems would be invaluable.

We would be glad to perform trial work necessary to support the registration of this product in California strawberries. Please let me know if you have needs in this regard, and if we can serve you in this capacity.

Sincerely,

Mike D. Nelson, Ph.D.
VP / Field Research Director

GREEN VALLEY FARM SUPPLY, INC
10 GONZALES RIVER ROAD
GONZALES, CA 93926

Dr. Gary Thompson
Global Technical Expert of
Spinosad and Mac Chemistry
Dow AgroSciences
9330 Zionsville Road
308 Building /3F
Indianapolis, IN 46268-1054

Dear Dr. Thompson:

Dwain Morton, the Dow AgroSciences representative for our area, gave me a label on a product called Scythe*L. I have read this label and truly believe this product has a big fit in this area. He also told me there might be a possibility of this product being certified Organic. I am a PCA and write the recommendations on several hundred acres of Organic grown vegetables. The choices that I have in organic herbicides are very few and they don't work well.at all. The Organic Grower needs a product like Scythe*L. If it works, the usage would be large. My acres of organic produce are growing and I an desperate for a product like Scythe. Dwain also told me about another Organic product called Intrust. We are so looking forward to this product.

Dr. Thompson, please do what you can to get Scythe certified Organic and please do it ASAP.
If I can help you in any way, please let Dwain know or you can reach me at the following numbers.
Mob: 831-595-6331
E-mail: ?????????????