

A RESOURCE GUIDE

Fertilizer Research & Education Program



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BACKGROUND

Nitrate contamination of groundwater is a widespread problem in California and part of the nitrate comes from agriculture. Some of the agriculture sources of nitrate in groundwater are the target of the Fertilizer Research and Education Program—FREP, for short. FREP was created to advance the environmentally safe and agronomically sound use and handling of fertilizer materials.

A significant part of FREP's current work is concerned with nitrate contamination of groundwater. This work involves identifying and prioritizing the most nitrate-sensitive groundwater areas in California. FREP also works with growers, agriculture supply and service providers, researchers and public agencies, to develop, demonstrate and promote ways to reduce nitrate contamination and improve fertilizer use efficiency.

Today, FREP is participating in programs in several California farming areas where nitrate in groundwater is a significant problem. In these activities, FREP:

- Funds research to find out more about the crucial relationships among crops, irrigation methods and nitrate in the soil, as well as other environmental issues related to fertilizer use such as heavy metals.
- Delivers information to growers, researchers, the agricultural supply and service industry, government officials, and the public.
- Organizes educational programs, and supports the efforts of other organizations in this area.

This Resource Guide lists close to one hundred information products available from FREP. Included here are reports produced by FREP staff; educational videos; technical research reports covering vegetable, orchard and field crops; and plant and soil testing and monitoring. A section of relevant publications available from other sources and pertinent reprints from technical journals and agricultural media is also included.

June, 1995

California Department of Food and Agriculture
Fertilizer Research & Education Program
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Printed on recycled paper.

Most of the resources listed in this publication are available at no cost. High quality educational videos are available for a nominal fee. We are currently working to make these and other resources available electronically through the Internet. We welcome any comments you may have regarding the material covered in this publication and will be happy to help you find the information you may be looking for. Our phone number, fax and electronic mail address are listed on the internal cover.

We would like to take this opportunity to acknowledge the support of the fertilizer industry, our agency staff and management, and the many professionals that help make this a successful program.

Jacques Franco *Casey Walsh-Cady*

Jacques Franco & Casey Walsh-Cady
Fertilizer Research & Education Program
California Department of Food and Agriculture
Sacramento, California, June 1995

PROGRAM REPORTS

Fertilizer Research and Education Program: A Progress Report 1990 - 92

Details the nature and extent of the nitrate problem in California and the Fertilizer Research and Education Program's (FREP) activities as a response. The competitive grants program is outlined and project summaries are provided. Includes a reference section, maps, publication order form and statistical tables. (An updated report is scheduled for 1996.)

FREPG-PR1292

30 pp

Nitrate and Agriculture in California

This report prepared by university, industry, and government experts provides an overview of the nitrogen cycle, sources of nitrogen and public health concerns. Reviews data on levels of nitrate in groundwater in ten regions of California, details sources of nitrate from animal and irrigated agriculture. Presents management options and criteria for nitrate sensitive areas in California.

FREPG-NWG189

66 pp

Fertilizer Research and Education Program: Second Annual Conference Proceedings: 1993

Summaries of ongoing, new and completed FREP-sponsored projects. Includes updates, keynote speech, biographies and addresses of conference speakers and project leaders. (A new proceedings will be published in 1995.)

FREPG-PROC1193

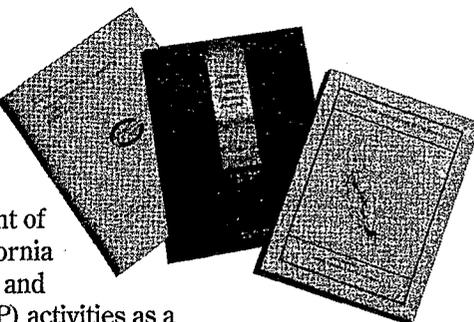
80 pp

Nitrate Contamination of Groundwater from Fertilizers: A Review of State Programs

Update of statewide efforts to reduce nitrates from fertilizers, both legislative and voluntary.

FREPG-RSP1092

7 pp



Our Priceless Water: Taking Title to Clean Water Protection (Vol. 1 and 2)

Two special supplements to *California Farmer*. Includes articles on the health of California's water, nitrate sensitive areas, best management practices, the use of nitrogen quick tests and information on the Certified Crop Advisor Program.

FREPG-CAFR0494

8 pp ea.

California's Experience with a Voluntary Approach to Reducing Nitrate Contamination of Groundwater

This article appeared in the Nutrient Management Special Supplement to the *Journal of Soil and Water Conservation*. It provides an overview of FREP and California's nitrate problem as it relates to irrigated agriculture. It includes an assessment of the progress to date and continuing challenges.

FREPG-JSWC0394

6 pp

VIDEOS

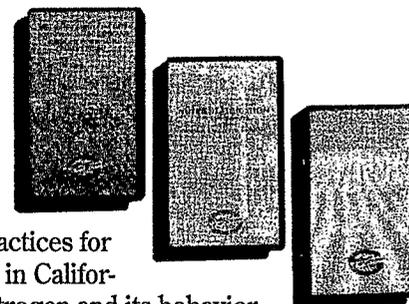
Best Management Practices for Nitrogen and Water Use in Irrigated Agriculture

Defines and illustrates technologies and handling practices for best management of nitrogen in California. It discusses the role of nitrogen and its behavior in the environment, illustrates seven best management practices, and discusses nitrate sensitive areas in California, including two case studies. A study guide is included.

VID-KLAA1293

30 min

\$20



Drip Irrigation and Nitrogen Fertilization Management for California Vegetable Growers

Describes the use of practical drip irrigation scheduling techniques, the development of efficient nitrogen fertilization regimes, and the uses and limitations of fertility and soil monitoring techniques. This knowledge is applied to California's cool season vegetable crops. A 36 page reference booklet is included.

VID-HART0694

22 min

\$20

Coming in
1995

Nutrient Education for Salespersons in the Nursery and Landscape Industry

This new video is designed to help individuals selling fertilizers in the home consumer market make correct and knowledgeable recommendations to their customers. It covers the basic elements of plant nutrition, proper application, storage and disposal, and guidelines for the three plant groups: turf; flowers, fruit and vegetables; and trees and shrubs. A study guide is included.

VID-JENK0695

30 min

\$20

Additional videotapes are detailed in "Available from Other Sources" section.



VEGETABLE CROPS

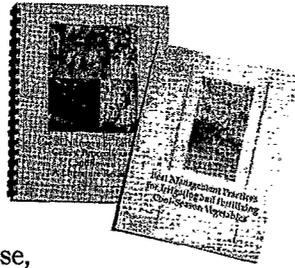
Improvement of Nitrogen Management in Vegetable Cropping Systems in the Salinas Valley and Adjacent Areas
Summarizes investigations into drip irrigation practices which can increase fertilizer use efficiency in the Salinas Valley. Described in this report are an evaluation of cover crop use in vegetable crops, an examination of drip-irrigation as a vegetable crop management tool, and a review of methods for estimating nitrate leaching.

FREPP-PETT0894

105 pp

Use of Nitrogen by Lettuce, Celery, Broccoli and Cauliflower: A Literature Review

Extensive literature review of lettuce, celery, broccoli, and cauliflower. Comprises 240 studies on cool-season vegetables, summarizing patterns of crop nitrogen uptake, fertilizer nitrogen use, irrigation and water use, and, when available, fate of nitrogen applied to crop.



FREPP-STIV692

79 pp

Best Management Practices for Irrigating and Fertilizing Cool-Season Vegetables

A guide outlining best management practices for California's cool-season vegetables. Practical guidelines for fertilizing and irrigating for optimizing fertilizer use efficiency are provided. A revised and improved edition will be available in 1996.

FREPP-PETT1292

10 pp

Optimizing Drip Irrigation Management for Improved Water and Nitrogen Use Efficiency for Vegetables

Report of a research and education project designed to improve irrigation and nitrogen fertigation management practices of commercial vegetable growers. Includes a comparison of drip irrigation scheduling techniques on fresh-market tomatoes and peppers. Evaluates several field nitrogen monitoring techniques. The use of buried anion exchange resin traps to evaluate nitrate loss is also discussed.

FREPP-HART1092

26 pp

Coming in
1996

Nitrogen Quick Tests for Vegetables: A Grower Handbook

This new handbook provides the latest information on using fresh-sap nitrogen measurements to manage fertilizer applications for lettuce, broccoli, cauliflower, celery, cabbage, onions and sweet corn. Sampling, calibrating and using the Cardy meter are also covered.

Coming in
1996

Nitrogen Management through Intensive On-Farm Monitoring

Summarizes results from an investigation of the accuracy, labor intensity and cost of on-farm monitoring techniques for soil and tissue nitrogen status. Baseline data on nitrogen uptake rates and tissue nitrogen sufficiency levels for the cool-season vegetable crops are included. The report documents the effect of best management practices, (drip irrigation, fertigation and intensive monitoring) on crop yield, and water and nitrogen use.

Coming in
1996

Diagnostic Tools for Efficient Nitrogen Management of Vegetables in the Low Desert

Summarizes results from an evaluation of several diagnostic tools to aid in the efficient management of nitrogen for vegetables produced in the low desert. The tools include dry midrib and petiole tests, sap midrib and petiole tests with the Cardy meter, absorbance using the chlorophyll meter, and various reflectance technologies including digital analysis of aerial photographs.



ORCHARD & VINE CROPS

Influence of Irrigation Management on Nitrogen Use Efficiency, Nitrate Movement and Groundwater Quality in a Peach Orchard

Final report of multi-year investigation into soil nitrate movement under different low-volume irrigation regimes and the interaction of fertilizer use and irrigation on yield and fruit quality.

FREPP-JOHN1093

36 pp

The Effects of Various Cultural and Environmental Factors on Nitrogen Use Efficiency and Nitrate Leaching in Stone Fruit Orchards: A Literature Review

A comprehensive report investigating nitrogen use efficiency and nitrate leaching in stone fruit orchards. Reviews plant-available nitrogen, nitrogen fertilization (timing and amounts) and its relationship to irrigation practices.

FREPP-JOHN892

20 pp

Nitrogen Fertilizer Management to Reduce Groundwater Degradation

Report of multi-year investigation studying the relationship between leaf nitrogen concentration and the rate of applied nitrogen fertilizer to almond orchards in Stanislaus County. Results show that annual nitrogen applications may not be required to maintain productivity.

FREPP-WEIN0394

8 pp

Potential Nitrate Movement Below the Root Zone in Drip Irrigated Almonds

Final report of a study assessing nitrate movement under drip with varying levels of nitrogen in Colusa County.

FREPP-MEYE593

10 pp

Development of Diagnostic Measures of Tree Nitrogen Status to Optimize Nitrogen Fertilizer Use

Final report of a project to develop improved plant nitrogen monitoring techniques. Includes concentration, composition and distribution of a range of nitrogenous compounds in almonds and nectarines.

FREPP-BROW0695

5 pp

Nitrogen Efficiency in Drip Irrigated Almonds

Final report of research project investigating the fate of fertilizer nitrogen applied to a drip-irrigated almond orchard under acidified soil conditions.

FREPP-ZAS0794

12 pp

Citrus Growers Can Reduce Nitrate Groundwater Pollution and Increase Profits

Final report of a two-year study of the effects of foliar urea applications on fruit set, yield, thrip populations and fruit scarring in Tulare County.

FREPP-LOV0894

9 pp

Crop Management for Efficient Potassium Use and Optimum Winegrape Quality

Report of a study investigating the potential to improve potassium fertilizer use efficiency for winegrapes grown on heavy clay soils in Napa and Sonoma Counties. The investigation is considering fertilizer method and placement, manipulation of water content, reduction of potassium fixation and rootstock selection for improved potassium efficiency.

FREPP-MATH0495

27 pp

Field Evaluation of Water and Nitrate Flux Through the Root Zone of a Drip-Irrigated Vineyard

Final report of a study determining the nitrate flux below the root zone of a chemigated, drip-irrigated, Thompson seedless vineyard under optimum conditions in Fresno County. An evaluation of acceptable methods to prevent root intrusion in drip tape is included.

FREPP-GRIM1092

21 pp



Effects of Four Levels of Applied Nitrogen on Three Fungal Diseases of Almond Trees

Summarizes results from a study investigating the effect of four levels of applied nitrogen on brown rot blossom and twig blight, green fruit rot, and hull rot on almond trees in Stanislaus County.



Avocado Growers Can Reduce Nitrate Groundwater Pollution and Increase Yield and Profit

Results of a project researching the use of foliar boron and urea on avocados at early bloom to increase yield and determine if foliar applications can replace part of the annual soil applications in Ventura County. Includes a cost/benefit analysis of the treatments.

Coming in
1996

Using High Rates of Foliar Urea to Replace Soil-Applied Fertilizer in Early Maturing Peaches

Results of a study investigating the use of fall-applied of foliar urea on early season peaches as an alternative to soil-applied fertilizers in Fresno County. The study is looking at optimum timing and concentration of one or two foliar urea sprays and is studying tree productivity, fruit quality and vegetative growth.

FIELD CROPS

Nitrogen Fertilizer Management: Strategies for Increased Wheat Protein

A brochure summarizing four years' research on increasing wheat protein. Multi-site research showed that protein levels can be raised by applying nitrogen fertilizer at flowering.

FREPP-CWC0192

Establishing Updated Guidelines for Cotton Nutrition

Annual report of comprehensive effort to provide cotton growers with updated fertility recommendations accounting for newer high-yielding varieties. The work focuses on establishing critical nitrate levels for leaf growth and function; the feasibility of delaying nitrogen applications to match availability to crop demand; and improving the predictive ability of soil potassium tests.

FREP-WEIR0194

6 pp

Coming in
1995

The Effects of Various Phosphorous Placements on No-Till Barley Production

Describes the results of a project researching the use of various sub-surface phosphorous placements and their effects on the growth and yield of cereal grains using a no-till farming system. The project is using a specially modified planting equipment which applies the seed and fertilizer simultaneously.

MISCELLANEOUS

Compost Production and Utilization: A Grower's Guide

Concise, up-to-date guide to composting for growers. Covers advantages and disadvantages of composts, their effects on soil properties, nitrogen dynamics, plant nutrients and growth. Provides how to's for growers, including management techniques, tools, and equipment. Includes legal aspects of composting and sample calculations.

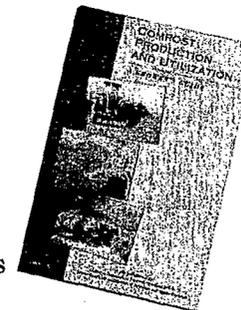
FREPP-VANH0695

Impact of Microbial Processes on Efficient Use of Fertilizers from Organic and Mineral Sources

Report of an investigation into the relationships among microbial biomass and activity, soil fertility parameters, crop tissue levels and crop yield and quality. The study is part of a UC Davis farming systems project in corn and tomatoes grown under three different nitrogen management systems in Yolo County, including nitrogen from mineral sources, cover crops, and cover crops supplemented with mineral sources.

FREPP-SCOW0395

29 pp



PLANT & SOIL TESTING & MONITORING

(See also separate entries in Vegetable and Orchard and Vines sections.)

Techniques for Sampling Soil Nitrates: Ceramic Cup Extractors

Reviews practical aspects of measuring nitrate in soil solution by use of porous cups buried in the soil and attached to vacuum lines. Points out need for care in interpreting nitrate concentration data obtained from suction cup samplers.

FREPP-HAND1093

11 pp

Determination of Soil N Content In-Situ

Comprehensive literature review of up-to-date progress made in site-specific crop management (SSCM), geographic information systems (GIS), and sensor technology for "real time" nutrient application.

FREPP-UPAD0593

38 pp

A Quick Test Procedure for Soil Nitrate-Nitrogen

This short article details a procedure for extracting and rapidly measuring nitrate-nitrogen in soil.

Coming in
1995

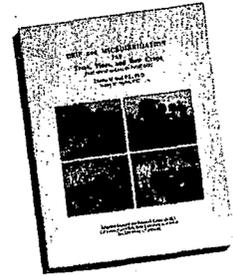
Use of Ion Exchange Resin Bags to Monitor Soil Nitrate

Summarizes results of an investigation into the use of anion exchange resin bags for monitoring nitrate leaching in the soil profile. This technique is important because it measures soil nitrate in the profile without destructive sampling.

AVAILABLE FROM OTHER SOURCES

Drip and Micro-Irrigation for Trees, Vines and Row Crops

This book contains valuable information currently unavailable from any other source. It covers new filtration concepts, chemical injection, designing for global uniformity, management and design for drip, micro-irrigation, row crops, and buried drip on trees and vines. Also includes layout examples and complete step-by-step design samples. It is an excellent study guide for Irrigation Association certification. (260 pp, \$34.95)



To order, see next entry.

Fertigation

This book is the new authority on chemical and fertilizer injection through irrigation systems. It covers injection equipment, diagnosis of plant and soil fertility needs, safety information and current regulations. It provides the latest research on nitrogen transformation and uptake and describes other nutrient processes. Detailed information is given for many fertilizers and minerals.

To order, contact: Irrigation Training and Research Center,
Cal Poly State University, San Luis Obispo, CA 93407,
(805) 756-2434.

Integrating Agricultural and Fertilizer Education into California's Science Framework Curriculum

Six educational units on plant science and crop fertility are available for grades K-12.

To order, contact: The California Foundation for Agriculture in
the Classroom, 1601 Exposition Blvd. Sacramento, CA 95815,
(916) 924-4380.

Sustainable Soil Management: Proceedings

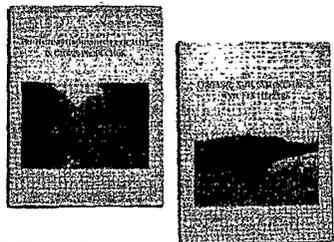
Proceedings of symposium held in April 1993 exploring the definition and importance of soil quality and how one can make improvements. Also includes results of comparative research on conventional and alternative production systems. (90 pp., \$10)

To order see next entry.



Organic Soil Amendments and Fertilizers

Organic soil amendments and fertilizers are used to enhance soil quality and promote plant growth. This publication includes a practical summary of the benefits and value of organic matter, provides some guidelines for evaluating organic materials, and describes many of the materials available in California. (36 pp, \$5)



Both Sustainable Soil Management: Proceedings and Organic Soil Amendments and Fertilizers are available from: SAREP-UC Davis, Davis, CA 95616, (916) 757-3277.

Protecting Groundwater Quality in Citrus Production

Offers practical and economical methods for reducing the movement of agricultural chemicals to groundwater in citrus. Topics covered include: wellhead protection, weed control, nitrogen management, irrigation management and the use of cover crops. (40 pp, \$5)

To order, contact: UC ANR Publications, Publication #21521, 6701 San Pablo Ave., Oakland, CA 94608-1239, (510) 642-2431.

Cover Crops for Clean Water

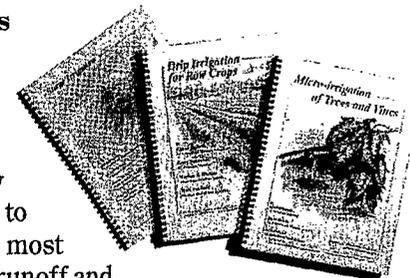
The Proceedings of an international conference held in 1991, in Jackson, TN. Includes valuable information on the role of cover crops in water quality management, including reducing water runoff, soil erosion, agrichemicals lost in runoff and nitrate leaching to groundwater. (198 pp, \$15)

To order, contact Soil and Water Conservation Society, 7515 N.E. Ankeny Rd., Ankeny, IA 50021-9764, (800) 843-7645

Drip Irrigation for Row Crops

This new publication covers everything growers need to know to design and operate a drip system for irrigating row crops. The manual explains how drip irrigation makes it possible to place water precisely where it is most needed while reducing surface runoff and deep percolation. (175 pp, \$15)

To order, see Surge Irrigation.



Micro-Irrigation of Trees and Vines

This publication covers a wide variety of design and management issues associated with micro-irrigation. Based on the authors' field experience, this manual explains what to look for in a well-designed micro-irrigation system, and how to maintain and manage it for efficiency and uniformity. (138 pp, \$15)

To order, see next entry.

Surge Irrigation

This new manual will help growers irrigate more efficiently using a surge technique in which water is turned on and off as it flows down the furrow. This practice can reduce surface runoff and deep percolation, save water and reduce energy costs. Includes information on timing, valve selection, the use of flowmeters, and injecting fertilizer. (48 pp, \$10)

"Drip Irrigation for Row Crops", "Micro-Irrigation of Trees and Vines" and "Surge Irrigation" are available from: Cooperative Extension Office, Land, Air, Water Resources, 113 Veihmeyer Hall, UC Davis, Davis, CA, (916) 752-1130.

Plant, Soil, and Water Reference Methods for the Western Region

This manual details plant tissue, soil and water analytical methods designed to standardize methodologies used in the Far West. It is published by the Western Regional Extension Program produced in cooperation with the Far West Fertilizer and Agrichemical Association. (58 pp)

To order, contact: Ray Gavlak, Plamer Research Center, 533 E. Fireweed Ave., Palmer, AK 99645, (907) 746-9467.



Best Management Practices

Water

- Water: Making the Most of It BMP-CTGR691
- Water Wizardry BMP-OLTM0793

Vegetables

- FREP Project Monitors Nitrogen (in vegetables) BMP-BURN0693
- Put to the Test (on farm plant and soil testing) BMP-OLTM0595
- New Technologies in Nitrogen Testing for Cool Season Vegetables BMP-SCHUI0794
- Western Perspective: Squeezing the Most Nitrogen from Drip BMP-HART592
- Vegetable Nutrition Guidelines BMP-TYLE
- Winter Cover Crops Can Decrease Soil Nitrate, Leaching Potential BMP-JACK993
- Improving Fertilizer Use Efficiency and Reducing Contamination (for small vegetable farms) BMP-VOSS0193

Nuts

- Causes and Consequences of Over-Fertilization in Orchards BMP-WEIN0192
- Almond Nitrogen Water Use Study Supports Reduced Rates BMP-BURN0295
- Nitrogen Can Help or Hinder Almond Trees BMP-BRYA0495
- Feeding Time: Tips on Spring Nutrition of Almonds BMP-ASAI0194

- Towards Optimizing Nitrogen in Walnuts BMP-KELL492
- Cutting Off Irrigation Early May Reduce Almond Hull Rot BMP-TEVI0594

Field Crops

- Tomatoes Respond to Simple Drip Irrigation Schedule and Moderate Nitrogen Inputs BMP-HART394
- Drip On Tomatoes Passes Efficiency Test BMP-VEG494
- Diagnostic and Recommendation Integrated System (DRIS) Norms Development (for processing tomatoes) BMP-CAPT1293
- Nitrogen And Potassium Fertilization for Cotton BMP-WEI593
- Nitrogen Management Strategies for Desert Cotton Production BMP-SILV394
- Potassium Fertility Studies in Cotton BMP-MUNK0394

Citrus

- Citrus Herbicides and Groundwater Quality BMP-INGE492
- Nitrogen Nightmares (in Citrus) BMP-WITN0694
- Citrus Fertilization BMP-BEND394
- Leaf Ahead - Citrus Growers want to reduce soil applied N BMP-RICH393

Grapes

- Nitrogen Fertilizer Rates, Timing BMP-CHRI1092

Horticulture

- Controlled-Release Fertilizers Affect Nitrate Nitrogen Runoff from Container Plants BMP-YEAG0493

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ORDER FORM

Please send me the following publications at no cost. For each video ordered I have enclosed a check payable to Cashier/CDEA for \$20. Discounts are available on volume orders. Call FREP for details.

*Send your completed form to: Casey Walsh Cady or Jacques Franco
Fertilizer Research and Education Program
California Department of Food and Agriculture
1220 N Street, Sacramento, CA 95814
(916) 653-5340, FAX (916) 653-2407*

#	CODE #	TITLE	COST
TOTAL			

Name _____

Affiliation _____

Address _____

City _____ State _____ ZIP Code _____

Phone # _____

How do you identify yourself: (Check as many as apply).

- | | |
|---|--|
| <input type="checkbox"/> Academic/extension | <input type="checkbox"/> Ag supply and service |
| <input type="checkbox"/> Fertilizer industry | <input type="checkbox"/> Grower |
| <input type="checkbox"/> Local/regional govt. | <input type="checkbox"/> Grower organization |
| <input type="checkbox"/> State/federal govt. | <input type="checkbox"/> Media |
| <input type="checkbox"/> Non-profit/education | <input type="checkbox"/> General public |
| <input type="checkbox"/> Consultant | <input type="checkbox"/> Other |

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