

Crop Profile for Rapini in California

Prepared: September, 2000

General Production Information

- Rapini is a minor crop in the U.S. with approximately 3,500 acres produced annually in California (2).
- California produces approximately 90% of the rapini grown in the U.S. (2).
- Monterey is the top rapini-producing county in California with 2,537 acres having a value of \$8,520,000 in 1998.(3).
- The cost to produce (i.e., grow) a carton of rapini weighing in the range of 18 - 20 pounds and containing 20 bunches of rapini ranges from \$4.00 to \$5.50 per carton (2).
- The cost to harvest (i.e., harvest and handling) a carton of rapini containing 20 bunches of rapini ranges from \$7.00 to \$8.50 per carton (2).

Introduction

The purpose of this document is to provide the general conditions associated with the production of rapini (Broccoli raab) in California, with comments on other production areas as appropriate. This document is provided in cooperation with D'Arrigo Brothers Company of California (D'Arrigo) under the United States Department of Agriculture CSREES Award No. 99-34381-8346. D'Arrigo is a family owned company that was formed in 1923. D'Arrigo farms in California and Arizona and produces rapini on a year round basis in California.

Rapini is a highly regarded mustard potherb in Italy and other Mediterranean countries. It is frequently called broccoli raab, Italian turnip, or cima de rapa. Rapini is an annual resembling sprouting broccoli, but develops much smaller less compact inflorescence. Leaves are petiolate, deeply lobed, dark green, and glossy. Tender young shoots, foliage, and the young inflorescence are edible (1).

The results of almost twenty (20) years of research conducted on rapini by D'Arrigo points to the need to have as many pest management tools as possible in order to continue to be able to provide the United States (U.S.) consumer with an economical supply of high quality rapini on a daily basis throughout the year.

It is very clear that plant breeding, and the development of resistant cultivars is one of the keys to the economical production of rapini in California. However, it is also clear that, at least in the near future, plant breeding by itself can not provide all the desired characteristics of weed, insect, and disease resistance along with all of the other desirable traits required for the varied and diverse rapini production regions in California.

Production Regions

Rapini is primarily produced in the coastal production regions of Monterey County, with winter production in Imperial County (2).

Cultural Practices

GENERAL INFORMATION

Rapini is considered a cool-season crop and is grown on a number of soil types. Planting and harvesting schedules are determined well in advance of planting to ensure a continuous supply of rapini throughout the year. Producers of rapini either own and/or lease land for production to ensure adequate acreage to meet their marketing requirements.

CULTIVAR DEVELOPMENT

D'Arrigo conducts their own breeding program and develops cultivars for their own use. Other rapini growers normally purchase rapini seed from seed companies. Plant breeding is one of the key ingredients in an Integrated Pest Management (IPM) program, and D'Arrigo-supported research is designed to develop cultivars with resistance to disease related problems and to meet the specific needs of the individual growing areas and time periods. Specific cultivars planted at the proper time, and in the proper location, ensure that desirable characteristics, such as disease resistance, will be maximized and that undesirable characteristics will be minimized.

PLANTING

Rapini seed is planted by the grower at depths of approximately 1/16 to 1/4 inches. Rapini is grown on raised 80-inch beds with 16 to 18 seedlines per bed. Since rapini is planted to a stand, thinning is not required.

PRODUCTION

Growers are primarily responsible for all production related activities including land preparation, cultivation, fertilization, irrigation, and the use of pesticides. The major spring, summer, and fall production region in California is in Monterey County, with winter production in Imperial County. The general growth period from planting to harvesting in Monterey County ranges from 45 to 75 days and Imperial County from 55 to 70 days (2).

HARVEST

In California rapini is harvested by hand cutting of the young edible shoot tips. The shoots are cut so that each has a length from 6 - 8 inches. Only the tender shoots are harvested and each, with a few attached leaves, are collected, bundled together, and placed into fiberboard cartons. There are usually 20 bunches of rapini per carton, and the average weight of a carton ranges from 18 - 22 pounds.

All rapini is harvested in the field and not subject to washing at the time of harvest. Harvested rapini is placed onto trucks which transport the rapini to a cooling facility. All rapini is cooled, usually within 1 to 4 hours after harvesting, and rapini is typically hydrocooled at temperatures of 34 degrees F, and then top iced.

Rapini is shipped to the market in refrigerated trucks and temperatures in the range of 34-36 degrees F are maintained during shipment.

Pest Management

All applications of pesticides in California are under the control of the growers, and/or their Pest Control Advisor (PCA), or Pest Control Operator (PCO). Growers, PCA's, and PCO's work closely to insure that only registered pesticides are used and that they are used in compliance with all state and federal laws, rules and regulations, and labeled recommendations. Communication between growers, PCA's, and PCO's is maintained during the planting and production periods through frequent field visitations by grower representatives and/or their PCA's. The applicator must inform all affected parties in close proximity to the intended treated area (e.g., harvesting crews, weeding crews, irrigators etc.) of their intent to apply pesticides in advance of the application and must also post fields and file post-application paperwork with the appropriate state and/or federal agency. Closed systems are also mandatory for the application of Category 1 pesticides in California.

All information on pests and pesticides listed in this report relate to the production of rapini in California. All pests and pesticides mentioned in this report are listed in alphabetical order, and each such listing may, or may not, have any relationship to the importance of the pest or the use of an individual pesticide. Listing of percentage of acres treated for any material represents the total use of that individual pesticide as determined by the California Department of Pesticide Regulation (4). When the same material is used on more than one pest (e.g., aphids and lepidopterous larvae), the percentage of acres treated is the total for the state and each such use is not additive.

Data on individual pesticide use, as taken from the California Department of Pesticide Regulation (4), is presented in the text for 1998. Included in Attachment 1 are data about use for the three-year period from 1996 - 1998.

Insect Pests

A number of foliar insects damage rapini. Aphids are the predominant pests in California followed by various lepidopterous larvae (worms). From the standpoint of Integrated Pest management (IPM) and pest resistance management, it is essential that pesticides with different modes of action (e.g., organophosphates, nicotinyls, pyrethroids and insect growth regulators [IGR]) be available to reduce the potential for the buildup of resistance to one type of material. There are only a limited number of organophosphates and pyrethroids registered for use on rapini, with new IGR type materials in the process of being registered or under development. Pesticides are used alone, in combination, or in an alternative treatment regime to control the various insect pests that cause economic damage to rapini. Very seldom, if ever, are the individual types of products (e.g., organophosphates) used in combination or as an alternative treatment with another registered product in the same chemical family. *Bacillus thuringiensis* (BT) provides control of many worm species, but is not as effective as other chemicals, and often requires additional treatments to maintain economic control. While worms are feeding, and accumulating toxic amounts of BT, leaf and/or shoot tip damage to rapini invariably occurs.

When considering chemical controls the multiple use of individual products for the management of one, or more, pests that may be present at the time of the application is usually considered. For example, an application of diazinon or imidacloprid might be considered if the green peach aphid is the primary concern, while diazinon and spinosad might be substituted if both this aphid and the beet armyworm are present. It is also common to include a fungicide with an insecticide if both insects (e.g., aphids) and fungal pathogens (e.g., white rust) are present at the time of treatment.

The management of insect populations is extremely critical to the production of rapini. Not only do insects damage rapini, they also contaminate rapini by their presence, from their feeding, or from the depositing of excrement. The high quality standards currently in place in the rapini industry allow for minimal, if any, contaminated products reaching the market place.

APHIDS

Green Peach Aphid (*Myzus persicae*): This aphid causes serious problems primarily in the coastal regions. High populations of this aphid can stunt young plants. This insect also deposits honeydew, and under high populations causes quality problems in rapini. The primary foliar materials used for this insect are diazinon, imidacloprid and oxydemeton-methyl, with some imidacloprid also used as a soil treatment in the desert. A total of 1 to 2 total annual foliar treatments are applied for this aphid; primarily in the coastal regions. It should be noted that when imidacloprid or oxydemeton-methyl are used as foliar treatments they provide control of both the green peach aphid and the cabbage aphid.

Cabbage Aphid (*Brevicoryne brassicae*): This aphid is a sporadic problem but can cause serious problems in the coastal regions. Like the green peach aphid, this insect deposits honeydew, and under

high populations causes quality problems on rapini by distorting the leaves and causing them to curl. Cabbage aphids are also coated with a waxy bloom, which makes them difficult to control. The primary foliar materials used for this insect are imidacloprid and oxydemeton-methyl. A total of 1 to 2 total annual foliar treatments are applied for this aphid, primarily in the coastal regions. It should be noted that when imidacloprid or oxydemeton-methyl are used as foliar treatments they provide control of both the green peach aphid and the cabbage aphid.

The following information is provided to indicate the importance of each individual aphid pest by production region (2, 5):

PEST	MONTEREY COUNTY	IMPERIAL COUNTY
Green Peach Aphid	P	P
Cabbage Aphid	P	P

The two major production regions by county in California are: **Monterey** and **Imperial**.

P = Primary

S = Secondary

O = occasional

NA indicates that the listed pest is not yet known to be a problem in that region.

CONTROLS

Biological

A number of predators feed on the green peach aphid, including the following: convergent lady beetle (*Hippodamia convergens*); lacewings (*Chrysoperla* spp.); and syrphid flies (Family: Syrphidae)(7).

One natural enemy of the cabbage aphid is the parasitic wasp, *Diaeretiella rapae* (7).

A fungus (*Entomophthora aphidis*) can reduce populations of the green peach and cabbage aphid’s (7).

The use of predators and the aforementioned fungus are limited because of the growth period of the rapini crop, the transitory nature of aphids, high crop quality standards, and a low tolerance for insect contaminated products in the market place.

Chemical

Chlorpyrifos - Labeled PHI is 21 days. Chlorpyrifos is available under EPA SLN NO. CA-940001. Do to the 21 day PHI, chlorpyrifos is not widely used (2) and there was no reported use in 1998 (4).

Diazinon - Labeled PHI is 7 days. Typical PHI ranges from 7 to 14 days (2, 5). Diazinon is applied as a foliar treatment to approximately 58% of the state acreage (4) at an average rate of 0.5 lb. ai. per acre (2, 5). Approximately 13% of total use was in the coastal region and 87% in the desert (4). Loss of foliar treatments of this insecticide would impact aphid resistance management and IPM programs as it is used as an alternative treatment to other products (e.g., nicotinyls).

Imidacloprid - Labeled PHIs are 21 days (soil) and 7 days PHI (foliar). Typical PHI ranges from 45 to 60 days for the soil treatment and from 7 to 14 days for the foliar treatment (2, 5). Imidacloprid is applied as a preplant, in-furrow or post-seeding drench treatment at an average rate of 0.375 lb. ai. per acre or as a foliar treatment at an average rate of 0.05 lb. ai. per acre (2, 5). Imidacloprid was applied to approximately 79% of the state acreage in 1998, with 23% of use in the coastal region and 77% in the desert (4). Primary use in the coastal region is as a foliar treatment for aphids and in the desert as a soil treatment for the control of whiteflies and aphids. Label restrictions, which recommend that a foliar application of imidacloprid not follow a soil application in the same crop, curtail the use of this product close to harvest. Loss of this product would impact aphid and whitefly resistance management and IPM programs.

Malathion - Labeled PHI is 7 days. Malathion is not widely used, with 1998 use reported on < 0.5% of the state acreage (4). Research data and grower experience indicates that malathion is not an effective treatment for any of the aphid species attacking rapini (2, 5, 6). Loss of foliar treatments of this insecticide would have little, if any, impact on aphid resistance management and IPM programs.

Oxydemeton-methyl - Labeled PHI is 7 days. Typical PHI ranges from 7 to 14 days (2, 5). Oxydemeton-methyl is available under EPA SLN NO. CA-950002. It is applied as a foliar treatment to approximately 29% of the acreage (4) at an average rate of 0.5 lb. ai. per acre (2, 5). Approximately 88% of use was in coastal region and 12% in the desert in 1998 (4). Loss of foliar treatments of this insecticide would impact aphid resistance management and IPM programs as it is used as an alternative treatment to other products (e.g., nicotinyls).

Pyrethrins - Labeled PHI is 0 days. Pyrethrins are not widely used, with 1998 use reported on < 0.5% of the state acreage (4). Research data and grower experience indicates that Pyrethrins are not an effective treatment for any of the aphid species attacking rapini (2, 5).

Rotenone - Labeled PHI is 0 days. Rotenone is not widely used and in 1998 there was no reported use in the state (4).

Note to use by region:

COASTAL (75% of CA production) - Monterey County.

DESERT (25% of CA production) - Imperial County.

LEPIDOPTEROUS LARVAE

Beet Armyworm (*Spodoptera exigua*): This insect causes serious damage to rapini, and is most prevalent during fall production in the desert regions. Reduced stands can result from high insect populations. The primary materials used for this pest are cypermethrin, methomyl, spinosad, and tebufenozide with 1 to 2 total annual treatments applied in the coastal and desert regions (winter and spring) and 1 to 3 total applications under the high populations in the desert in the fall.

Cabbage Looper (*Trichoplusia ni*): This insect can cause serious damage to rapini in all areas, but is more of a problem in the coastal regions. It is particularly a problem near harvest when larvae feed on the heads causing internal damage and depositing frass. The primary materials used for this pest are BT, cypermethrin, methomyl, and spinosad with 1 to 2 total treatments applied primarily in the coastal region on an annual basis.

Diamondback Moth (*Plutella xylostella*): This insect can cause serious damage to rapini in all areas, but is more of a problem in the coastal regions. This pest is a problem especially near harvest when larvae feed on the heads causing internal damage and depositing frass. The primary materials used for this pest are BT, cypermethrin, and spinosad, with 1 to 2 total treatments applied in the coastal region on an annual basis.

The following information is provided to indicate the importance of each individual lepidopterous pest by production region (2, 5):

PEST	MONTEREY COUNTY	IMPERIAL COUNTY
Beet Armyworm	P	P
Cabbage Looper	P	S
Diamondback Moth	P	O

The two major production regions by county in California are: **Monterey** and **Imperial**.

P = Primary

S = Secondary

O = occasional

NA indicates that the listed pest is not yet known to be a problem in that region.

CONTROLS

Biological

The most common parasites of the beet armyworm are wasps (e.g., *Hyposoter exiguae* and *Chelonus insularis*), and the tachinid fly (*Lespesia archippivora*) - (7).

Parasites that feed on lepidopterous looper eggs or larvae include the following: parasitic wasp (*Trichogramma* spp.; tachinid fly (*Voria ruralis*); and other wasps (*Copidosoma truncatellum*, *Hyposter exiguae*, and *Microplitis brassicae*) - (7).

Two wasps are known to be specific parasites of Diamondback moth larvae and/or eggs: *Diadegma insularis* and *Trichogramma pretiosum* (7).

Predators also play a role in reducing populations of lepidopterous larvae. Two predators that feed on lepidopterous eggs are minute pirate bugs (*Orius* spp.), and bigeyed bugs (*Geocoris* spp.) - (7).

Viral diseases (e.g., nuclear polyhedrosis virus) also play a role in reducing populations of lepidopterous larvae (7).

Parasites, predators, and viral diseases may assist in reducing lepidopterous egg and/or larval populations. However, their use is limited because of the short time crops are in the field, high crop quality standards, and a low tolerance for insect contaminated products in the market place.

Chemical

***Bacillus thuringiensis* (BT)** - Labeled PHI is 0 days. BTs play an important role in IPM programs. BTs are applied as foliar treatments to approximately 11% of the state acreage (4). Approximately 6% of use was in the coastal region and 94% in the desert in 1998 (4). BTs usually require additional applications to be as effective as other products (e.g., carbamates, pyrethroids and IGR). Additionally, while worms are ingesting and accumulating toxic amounts of BT type products their feeding on leaves and shoot tips are causing crop damage.

Cypermethrin - Labeled PHI is 1 day. Typical PHI ranges from 7 to 14 days (2, 5). Cypermethrin is applied as a foliar treatment to approximately 25% of the acreage (4) at an average rate of 0.125 lb. ai. per acre (2, 5). Approximately 97% of use was in the coastal region and 3% in the desert in 1998 (4). Loss of this product would impact worm resistance management and IPM programs as it is used as an alternative treatment to other products (e.g., carbamates and IGR).

Methomyl - Labeled PHI is 3 days. Typical PHI ranges from 7 to 14 days (2, 5). Methomyl is available under EPA SLN NO. CA-900034. Methomyl is applied as a foliar treatment at an average rate of 0.9 ai. per acre (2, 5). Methomyl was used on approximately 5% of state acreage in 1998 with all use in the coastal region (4). Loss of this product would impact worm resistance management and IPM programs as it is used as an alternative treatment to other products (e.g., pyrethroids and IGR).

Spinosad - Labeled PHI is 1 day. Typical PHI ranges from 7 to 14 days (2, 5). Spinosad is applied as a foliar treatment to approximately 28% of the acreage (4) at an average rate of 0.1 lb. ai. per acre (2, 5). Approximately 58% of use was in the coastal region and 42% in the desert in 1998 (4). Use of this material is expected to increase, and the loss of this product would impact worm resistance management and IPM programs as it is used as an alternative treatment to other products (e.g., carbamates, pyrethroids and IGR).

Tebufenozide - Labeled PHI is 7 days. Typical PHI ranges from 7 to 14 days (2, 5). Tebufenozide is applied as a foliar treatment at an average rate of 0.125 lb. ai. per acre (2, 5). Data are not available on use by region. Use of this material is expected to increase, and the loss of this product would impact worm resistance management and IPM programs as it is used as an alternative treatment to other products (e.g., carbamates and pyrethroids).

Note to use by region:

COASTAL (75% of CA production)- Monterey County.

DESERT (25% of CA production) - Imperial County.

WHITEFLIES

Two whiteflies *Bemisia tabaci* and *B. argentifolii* transmit viruses that infect rapini. These insects cause serious problems, primarily in the desert regions, and under high populations, reduce rapini stands, and/or cause severe plant stunting. Feeding by whiteflies also produces a sticky honeydew on the leaves upon which a black, sooty mold may develop. The primary material used for these insects is an application of imidacloprid at planting.

CONTROLS

Biological

Several wasps including those in the *Encarsia* and *Eretmocerus* genera parasitize whiteflies (6).

Bigeyed bugs (*Geocoris* spp.) and larvae of lacewings (*Chrysoperla* spp.) feed on whitefly nymphs as does the lady beetle (*Delphastus pusillius*) - (6).

The presence of parasites and predators minimally reduces populations of whiteflies, however, because of high whitefly populations economic control is not obtainable.

Chemical

Imidacloprid - Labeled PHIs are 21 days (soil) and 7 days PHI (foliar). Typical PHI ranges from 45 to 60 days for the soil treatment and from 7 to 14 days for the foliar treatment (2, 5). Imidacloprid is applied as a preplant, in-furrow or post-seeding drench treatment at an average rate of 0.375 lb. ai. per acre or as a foliar treatment at an average rate of 0.05 lb. ai. per acre (2, 5). Imidacloprid was applied to approximately 79% of the state acreage in 1998, with 23% of use in the coastal region and 77% in the desert (4). Primary use in the coastal region is as a foliar treatment for aphids and in the desert as a soil treatment for the control of whiteflies and aphids. Label restrictions, which recommend that a foliar application of imidacloprid not follow a soil application in the same crop, curtail the use of this product close to harvest. Loss of this product would impact aphid and whitefly resistance management and IPM programs.

Note to use by region:

COASTAL (75% of CA production)- Monterey County.

DESERT (25% of CA production)- Imperial County.

OTHER INSECT PESTS

Rapini is a host for other insects that do not presently cause economic damage. These insects include: Lygus bug (*Lygus hesperus*); Pea leafminer (*Liriomyza huidrobrensis*); and the Western Flower Thrips (*Frankliniella occidentalis*).

DISEASE MANAGEMENT

There are a limited number of foliar diseases that affect rapini production in California. D'Arrigo funded research has been concentrating on the development of rapini cultivars with resistance to white rust.

The management of diseases is extremely critical to the production of rapini. Not only do diseases damage rapini foliage (e.g, white rust), they also contaminate rapini as a result of tissue decay during shipment. The high quality standards currently in place in the rapini industry allow for minimal, if any, contaminated products reaching the market place.

FUNGAL DISEASES

White Rust (*Albugo candida*): White rust is an occasional disease of rapini. It can be serious under cool, wet conditions and is usually more prevalent during the late winter and early spring production seasons. The primary means of controlling this disease involve the application of metalaxyl (i.e., mefenoxam), however existing tolerances for this material limit its use.

There are two other fungal diseases that have been reported as diseases of rapini. They are powdery mildew (*Erysiphe cruciferarum*), and a leaf blight (*Alternaria brassicae*) - (8, 9). There is nothing currently registered that will control either of these diseases on rapini.

The following information is provided to indicate the importance of each individual disease by production region (2, 5):

PEST	MONTEREY COUNTY	IMPERIAL COUNTY
White Rust	P	NA

The two major production regions by county in California are: **Monterey** and **Imperial**.

P = Primary

S = Secondary

O = occasional

NA indicates that the listed pest is not yet known to be a problem in that region.

CONTROLS

Biological

D'Arrigo funded research is developing rapini cultivars with varying degrees of resistance to white rust.

Chemical - Foliar Disease Management

Fosetyl-al - Labeled PHI is 3 days. Fosetyl-al is not widely used and in 1998 there was no reported use in the state (4).

Metalaxyl (mefenoxam) - Labeled PHI is 7 days. Typical PHI ranges from 7 to 14 days (2, 5). Metalaxyl is available under EPA SLN NO. CA 960013. It is applied as a foliar treatment at a typical rate of 0.125 lb. ai. per acre (2, 5). Metalaxyl must be used in combination with another fungicide (e.g., Neem Oil). Metalaxyl was used on < 1% of the state acreage, with all use is in the coastal region (4).

Neem Oil - Labeled PHI is 0 days. Neem oil is used primarily in combination with other fungicides (e.g., metalaxyl). There was very little product used on rapini in 1998 (2, 5).

Note to use by region:

COASTAL (75% of CA production)- Monterey County.

DESERT (25% of CA production)- Imperial County.

BACTERIAL DISEASES

Bacterial Blight - (a pathovar of *Pseudomonas syringae*): Bacterial blight has been reported as a disease of rapini and can be a serious problem under certain production conditions (10). There is nothing currently registered that will control this disease on rapini.

VIRAL DISEASES

Viruses are not currently considered economic pests of rapini in California.

Nematodes

Nematodes are not currently considered economic pests of rapini in California.

Weeds

Although weed management is critical in the production of rapini, herbicides, other than those used in the desert for the control of grassy weeds, are seldom used due to the number of seedlines per bed and the competition from the crop. Although some weeds may emerge with the crop, once rapini is established it competes very well and weeds are seldom a problem on the bedtop area.

If not controlled, weeds increase the cost of production due to increases in the time required for their removal. Individual weeds (e.g., burning nettle and little mallow) can also create problems at harvest, since weed foliage can contaminate rapini at harvest. The high quality standards currently in place in the rapini industry allow for minimal, if any, contaminated products reaching the market place.

CONTROLS

Biological/Cultural

There are no current methods of providing biological control for either annual or perennial weeds that infest rapini.

Chemical

Bensulide - PHI is restricted by use as either a preplant or a preemergence treatment at planting. Typical PHI ranges from 45 to 75 days (2, 5). Bensulide is applied as either a preplant or preemergence treatment to approximately 3% of the acreage (4) at a typical rate of 5.0 lb. ai. per acre (2, 5), with all use in the coastal region (4). The loss of this product would have only a minimal economic impact on the production of rapini.

Chlorthal-dimethyl (DCPA) - PHI is restricted by use as a postplant/preemergence treatment. Typical PHI ranges from 45 to 75 days (2, 5). Chlorthal-dimethyl is applied as a preemergence treatment to approximately 55% of the state acreage (4) at a typical rate of 5.0 lb. ai. per acre (2, 5). Approximately 16% of use was in the coastal region and 84% in the desert in 1998 (4). This herbicide was discontinued by the original manufacturer, and current supplies are limited. However, it is expected to be available from a new manufacturer sometime in late 2000 or early 2001 (11).

Sethoxydim - Labeled PHI is 30 days. Typical PHI ranges from 30 to 45 days (2, 5). Sethoxydim is applied as a postemergence treatment at a typical rate of 0.3 lb. ai. per acre (2, 5). Sethoxydim use is restricted to the control of grassy species. Sethoxydim use was reported on 16% of the state acreage in 1998 with all use reported in the desert region (4).

Note to use by region:

COASTAL (75% of CA production)- Monterey County.

DESERT (25% of CA production)- Imperial County.

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References

1. Rubatzky, V. E. and Yamaguchi, M. 1997. World Vegetables, 2nd ed., Chapman & Hall, New York, pp. 404-405.
2. Personal Communication - D'Arrigo Brothers Company of California.
3. Monterey County Agricultural Commissioner 1998 Crop Report.
4. California Department of Pesticide Regulation - Pesticide Use Reports - 1998.
5. Personal Communication - D'Arrigo Brothers Company of California and/or their PCA's.
6. Personal Communication - Bill Chaney - University of California Cooperative Extension.
7. Integrated Pest Management for Cole crops and Lettuce - UC Publication 3307 - 987.
8. Koike, S. T. 1997. Broccoli raab as a host of *Alternaria brassicae* in California. Plant Dis. 81:552.
9. Koike, S. T., and Saenz, G. S. 1997. First report of powdery mildew, caused by *Erysiphe cruciferarum*, on broccoli raab in California. Plant Dis. 81:1093.
10. Koike, S. T., Henderson, D. M., Azad, H. R., Cooksey, D. A. , and Little, E. L. 1998. Bacterial blight of broccoli raab: A new disease caused by a pathovar of *Pseudomonas syringae*. Plant Dis. 82:727-731.
11. Umeda, K. University of Arizona, Maricopa County Office - Vegetables Newsletter vol VII, issue no. 7, July 14, 2000.

Appendices

Rapini Use Data 1996-1998

Pesticide	Acres Treated 1998	Acres Treated 1997	Acres Treated 1996
Bacillus thuringiensis	251	237	507
Bensulide	76	17	0
Chlorthal-Dimethyl	1473	419	1188

Cypermethrin	652	0	0
Chlorpyrifos	0	15	10
Diazinon	2239	37	899
Fosetyl-Al	0	97	0
Imidacloprid	2926	65	1322
Malathion	10	0	85
Metalaxyl	16	0	0
Methomyl	175	295	344
Oxydemeton-Methyl	721	702	647
Pyrethrins	10	155	510
Rotenone	0	14	4
Sethoxydim	357	35	0
Spinosad	708	289	0

Database and web development by the [NSF Center for Integrated Pest Managment](#) located at North Carolina State University. All materials may be used freely with credit to the USDA.