MILDEWCIDES FOR SQUASH PRODUCTION ON CALCAREOUS SOILS AND MANGANESE AND ZINC NUTRITION

C. W. AVERRE, III AND P. G. ORTH[1]

The production of squash (*Cucurbita pepo* var. *melopepo* (L.) Alef., principally var. Summer Crookneck) for the fresh winter vegetable market is big business in Dade County. In the 1964-65 crop year 3,610 acres were under cultivation with a value of over 1.5 million dollars (Dade County Agricultural Agent Office, 1965). Powdery mildew and downy mildew caused by *Erysiphe cichoracearum* D. C. and *Pseudoperonospora cubensis* (Bert. & Curt.) Rostow are serious diseases, and control programs must be followed for maximum yields (Parris, 1949). It has been observed by the senior author that powdery mildew is prevalent throughout the winter-growing season while downy mildew thrives during warm, humid, rainy periods. The recommended control measures are quite effective but are different (Brogdon *et al.*, 1965), and unless a careful diagnosis is made, ineffective control measures may be chosen. A material to control both mildews is needed. The state recommendation (Brogdon *et al.*, 1965) for control of powdery mildew is 8-12 oz. of Karathane per 100 gal. water or, during cool weather, 2-4 lb. of sulfur per 100 gal. water. Zineb WP 75, 2 lb. per 100 gal. water, or maneb WP 80, 1½ lb. per 100 gal. water, is recommended for control of downy mildew. Powdery mildewcides are generally used to eradicate the disease after it appears, but downy mildewcides are used to prevent the disease and thus are applied on a regular cycle which may be as short as 3-7 days.

Squash production in Dade County, Florida is generally on shallow, calcareous, rocky soils with pH between 7.5-8.0. Micro-nutrients which may limit crop production on such soils are iron, manganese, zinc, and copper (Allaway, 1957). The need for fertilizing vegetables with manganese in Dade County was discovered some years ago (Skinner and Ruprecht, 1930). Since many fungicides contain metals it is possible that crops derive nutritional as well as fungicidal benefits from them.

[1]Assistant Plant Pathologist and Assistant Soils Chemist respectively, University of Florida, Sub-Tropical Experiment Station, Homestead.

Florida Agricultural Experiment Stations Journal Series No. 2557.

The purposes of these tests were to (1) evaluate new products for the control of powdery and downy mildew, (2) find products to control both mildews simultaneously, and (3) determine if response to fungicides is related in part to their manganese and zinc content.

MATERIALS AND METHODS

The products, formulations, and rates used are presented in Tables 1, 2, and 3. Their manfacturers, composition and recommended rates are readily available (Lewis, 1963, 1964 and Sinclair, 1965).

The materials were mixed in 10 gallons of water just prior to spraying and kept in suspension with a circulating pump. Applications were made through 3 to 7 nozzles (depending on plant size) at 250 psi with tractor speed and nozzle number and arrangement adjusted for maximum coverage of leaf surfaces. Unless otherwise specified first applications were at the 3-4 leaf stage of the squash plant, and subsequent sprays were continued on a weekly schedule until the end of the test. The variety was Early Yellow Summer Crookneck Squash[2]. The treatments were in randomized blocks with four replications each consisting of one 25-foot row. Insofar as possible, commercial production practices were followed, including soil application of a 4-8-6-2-1 (N-P_2O_5-K_2O-MgO-MnO) fertilizer. The dates for the tests were as follows: Test 1, January 8-April 1, 1965; Test 2, September 28-December 8, 1965; and Test 3, February 4-May 2, 1966. In all tests incidence of watermelon mosaic virus was high in the late pickings.

RESULTS AND DISCUSSION

The results of Test 1 are presented in Table 1. The level of powdery mildew was very low in all plots until 2-3 weeks before the end of the test. None of the treatments was phytotoxic. The yields fall in two groups that are associated with presence or absence of Manzate-D in the treatment. Treatments 4, 5 and 6 indicate that high yields correlate with control of powdery mildew. However, Treatment 3 yielded just as much even though powdery mildew control was

[2]Seed provided by the Kilgore Seed Company.

Table 1. Effect of fungicides on incidence of downy and powdery mildews and yield response of Summer Crookneck Squash, Test 1[1/]

Treatment No.	Product	lb/100 gal	Downy Mildew rating [2/]	Powdery Mildew colonies [3/]	% Yield increase
1	Control		3.50 d	515 cd	0 b
2	Daconil	1.5	0 ab	559 d	21 b
3	Manzate-D	1.5	.75 abc	396 bcd	67 a
4	Karathane Manzate-D	.5 1.5	1.75 c	206 ab	55 a
5	Sulfur (wettable) Manzate-D	4.0 1.5	.50 ab	139 a	58 a
6	Karathane Sulfur (wettable) Manzate-D	.5 4.0 1.5	1.50 bc	235 ab	54 a

1/ Numbers in a column with a letter in common are not significantly different at the .05 level according to Duncan's Multiple Range Test.

2/ Rating based on a 0-5 scale when 0 = no disease through 5 = severe disease. Ratings were made 5 weeks after planting.

3/ Average number of colonies on 4 leaves. Counts made 11 weeks after planting.

significantly less than Treatment 5. A comparison of Treatment 2 and 3, which did not differ significantly in control of downy or powdery mildews, reveals a significant difference in yield response. This raises the possibility that the yield responses in Treatments 3, 4, 5 and 6 were related to manganese and zinc nutrition since neither metal was applied to Treatments 1 and 2 (Daconil does not contain metals). The combination of sulfur and Manzate-D (Treatment 5) applied on a weekly schedule on a preventative basis was the best treatment as measured by high yields and excellent control of both mildews.

In order to further evaluate the importance of zinc and manganese in spray programs, Daconil and Orthocide 50 (captan) were supplemented with Nu-Manese (MnO 48%) and Neutral zinc (ZnO 68%). This test also evaluated a number of fungicides primarily for the control of downy mildew. The treatments and results are presented in Table 2. The data show a reduction in the efficiency of Daconil as a downy mildewcide when Nu-Manese was added and they suggest a positive plant response from the additions of the metals. Orthocide 50-treated plants did not benefit from the addition of the two metals, and since powdery mildew was not controlled by this treatment it was speculated that disease was the limiting factor and not manganese or zinc. Daconil under the conditions looked very promising for the control of both mildews, and the increase in squash yields of plots so treated was very good. Polyram a zinc carbamate effected good downy mildew control, and the plots had the highest yields despite the fact that the treatment was started one week late. None of the treatments were phytotoxic.

Table 2. Downy and powdery mildew control and crop response with several fungicides and the effect of zinc and manganese supplements to Daconil and Orthocide 50[1/]

Treatment			Downy Mildew rating[2/]	Powdery Mildew rating[2/]	Rating of vine [3/]	Dry wt. of petioles (mg)	% Yield increase
No.	Product	lb/100 gal					
1	Control		3.8 e	4.0 c	5.00 f	177 e	0 d
2	Manzate-D	1.5	2.8 bc	2.8 b	2.38 bc	219 cde	17 bcd
3	Daconil	1.5	1.6 a	1.0 a	2.88 cd	245 bc	42 abc
4	Daconil Nu-Manese	1.5 .4	2.6 bc	1.0 a	2.12 b	293 a	53 a
5	Daconil Neutral zinc	1.5 .1	2.2 ab	1.2 a	2.75 bcd	278 ab	60 a
6	Daconil Nu-Manese Neutral zinc	1.5 .4 .1	2.5 bc	1.0 a	2.12 b	226 cd	62 a
7	Orthocide 50	2.0	3.6 de	5.0 d	4.00 e	191 de	30 abcd
8	Orthocide 50 Nu-Manese Neutral zinc	2.0 .4 .1	2.9 bcd	5.0 d	3.75 e	192 de	10 cd
9	Polyram [4/]	1.5	2.8 bc	3.2 b	1.25 a	204 cde	47 ab
10	Phaltan [4/]	2.0	3.2 cde	4.2 c	3.12 d	193 de	12 cd

1/ See footnote 1, Table 1.

2/ Rating based on a 0-5 scale where 0 = no disease through 5 = severe disease and were made 6 weeks after planting and 11 weeks in the case of powdery mildew.

3/ Vines were rated for size and color on a 1-5 scale where 1 = best and 5 = worst.

4/ Sprayings started 1 week later than previous treatments.

Leaves were sampled to determine if crop response could be evaluated by dry weight. Blades and petioles were separated before drying. The treatments affected petiole weight but not blade weight. This response was in general agreement with yield response.

A third test was started on February 4, 1966 primarily to evaluate powdery mildewcides. The treatments and results are presented in Table 3. Under the conditions of this test the TC 90 and Morocide (treatments 13 and 16) were slightly phytotoxic. The other products were not and all products reduced the incidence of powdery mildew to a greater or lesser extent. Powdery mildew was slow in becoming established and was probably never a limiting factor of production; hence, yield differences do not relate to disease control.

Conclusions

Maneb fungicides with zinc in combination with sulfur applied on a regular schedule provided the most effective control of both powdery and downy mildews of Summer Crookneck Squash. Daconil and Polyram were outstanding downy mildewcides but were unsatisfacory for control of powdery mildew. Several new prod-

Table 3. Effect of fungicides on incidence of powdery mildew and yields of Summer Crookneck Squash, Test 3[1/]

Treatment			Powdery mildew	% Yield
No.	Product	Amt/100 gal	rating [2/]	increase
1	Control		4.5 e	0 ab
2	Daconil	1.5 lb	3.8 e	- 3 ab
3	Manzate-D	1.5 lb	4.2 e	8 a
4	*Karathane	.5 lb	1.5 d	8 a
5	*Sulfur (WP)	4.0 lb	.5 abc	10 a
6	*Morestan 25WP	2.0 lb	0 a	0 ab
7	*Pipron 8LC	4.0 oz	0 a	1 ab
8	*TH 184-F 25WP	2.0 lb	0 a	2 a
9	*TH 265-F 20WP	2.0 lb	.2 ab	0 ab
10	TH 214-F 25WP	1.0 lb	1.5 d	- 8 abc
11	TC 90	2.0 qt	1.2 cd	-23 c
12	*4472 50WP	2.0 lb	1.0 bcd	8 a
13	*UC 19786 50WP	2.0 lb	0 a	- 6 abc
14	Morocide 50WP	1.0 lb	1.5 d	-19 bc

1/ See footnote 1, Table 1

2/ See footnote 2, Table 1

* Supplemented with Manzate-D as needed to control downy mildew

ucts and experimental compounds were excellent powdery mildewcides but did not control downy mildew. Thus a product to control both mildews is still urgently needed.

The results suggest that zinc and manganese in fungicides sprayed on squash plants are available to the plants, and that squash in Dade County responds favorably to these nutrients when disease is not a limiting factor. Further tests are needed to determine critically the value of zinc, manganese, iron, and copper in sprays in the absence of disease. The tests indicate the need to consider the role of micro-nutrients in evaluating plant response to fungicides.

LITERATURE CITED

Allaway, W. H. 1957. pH, soil acidity, and plant growth. In Soil. U.S. Dept. Agr. Yearbook 1957. 784 p.

Brogdon, J. E., M. E. Marvel, and R. S. Mullin. 1965. Commercial vegetable insect and disease control guide. Univ. Fla. Agr. Ext. Ser. Cir. 193E, 49 p.

Dade County Agricultural Agents Office. 1965. Dade ranks high as an agricultural county. Fla. Agr. Ext. Ser. Gainesville.

Lewis, F. H., Chmn. & ed. 1963. Fungicide-Nematocide Tests,, results of 1963. Vol. 19. American Phytopathological Society.

Lewis, F. H., Chmn. & ed. 1964. Fungicide-Nematocide Tests, results of 1964. Vol. 20. American Phytopathological Society.

Parris, G. K. 1949. Cucurbit mildews in Florida. Univ. Fla. Agr. Exp. Sta. Cir. S-1, 6 p.

Sinclair, J. B., Chmn. & ed. 1965. Fungicide-Nematocide Tests, results of 1965. Vol. 21. American Phytopathological Society.

Skinner, J. J., and R. W. Ruprecht. 1930. Fertilizer experiments with truck crops. Fla. Agri. Exp. Sta. Bull. 218.

CONTROL OF BUD NEMATODE ON STRAWBERRY[1]

S. J. LOCASCIO, G. C. SMART, JR., AND M. E. MARVEL[2]

ABSTRACT

Effective control of the bud nematode (*Aphelenchoides besseyi*) on strawberry plants was obtained with a 5 minute dip in a 300 ppm solution of zinophos. Dips for longer duration or at higher concentrations were often phytotoxic. However, good quality plants safely tolerated treatments of up to 15 minutes in 300 ppm zinophos. Dip treatments up to 600 ppm parathion for 30 minutes were ineffective in controlling the bud nematode.

Complete bud nematode control was difficult to obtain by nematicide applications on infested plants growing in the field. Population reductions and an improvement in visual plant growth were obtained with a number of nematicides including 10 and 20 pounds of Niagara 10242, 3 pounds of Bay 25141, and 30 pounds of Sarolex per acre. Complete control and excellent plant recovery were provided only with Bay 25141 at rates of 10 and 20 pounds per acre.

INTRODUCTION

The bud nematode, *Aphelenchoides besseyi*, injures strawberry plants by feeding on cellular contents of leaf buds causing a disorder known under several common names such as: summer dwarf, French bud, blind plant and crimp (4). It is commonly spread from area to area in movement of nursery plants (1). Small populations of this ectoparasite increase rapidly during hot, humid summer weather, and infested plants are unthrifty and produce few daughter plants. Brooks *et al.* (1) observed that losses were as much as 75% in individual plant nurseries and that infested plants produced less fruit than healthy plants. Early rogueing helps to reduce the spread of the bud nematode in the plant nursery but does not eliminate it. Even though parathion has been recommended for field control, limited tests with parathion sprays have provided only partial control (3, 5). Hot-water treatment of infested plants is effective (6), but time and temperature of treatment are critical and plants are often injured.

The purposes of the experiments reported here were to determine if an effective dip treatment of bare-rooted plants and a field treatment could be developed to control the bud nematode.

EXPERIMENTAL PROCEDURE

Three greenhouse dip-treatment experiments were conducted in the summer of 1966 at Gainesville, Florida. In the first study, initiated June 14, bud nematode infested 'Florida Ninety' strawberry plants obtained from a commercial field were dipped in 300 and 600 ppm solutions of zinophos (O,O-diethyl 0-2-pyrazinyl phosphorothioate) or parathion (O, O-diethyl, O-p-nitrophenyl phosphorothioate for 15 and 30 minutes. For each treatment, 24 plants were used. Immediately after treatment 12 of the plants were rinsed for 2 minutes in a water solution containing 5 ml/l of liquid detergent (Ivory). Six plants from each treatment were transplanted,

[1]Florida Agricultural Experiment Stations Journal Series No. 2539.

[2]Associate Horticulturist, Vegetable Crops Department; Assistant Nematologist, Entomology Department; Associate Vegetable Crops Specialist, Vegetable Crops Department, IFAS, University of Florida, Gainesville.