A well designed ditch and tile drainage system for level to gently sloping land may be used in reverse as an effective sub-irrigation system. The irrigation system selected should be designed to supply sufficient water to bring the soil moisture to near field capacity in the plant rooting zone.

The first step in design of drainage is the determination of economic factors that set up the frequency which a crop can be lost to flooded fields. Permanent drainage normally means flooding from 36 to 48 hours. In the central and southern Florida area, a 24-hour rain totaling 6.5 inches has a probability of once in 10 years. Since 2 inches of this total will be absorbed in the soil profile when using a 2-foot water table, only 4.5 inches of surface water must be removed; therefore, it would have been sheer foolish business to place our design criteria on an amount in excess of 3 to 4 inches per hour.

In conclusion, water content of most of our Flatwoods soils at field capacity will range from approximately 3.0 to 3.8 inches per 2 feet of depth.

LITERATURE CITED

1. Byron, O. C. 1960. Soils of Florida and Their Crop Adaptation. Bul. No. 42, State of Florida, Department of Agriculture, R June, 1960.

2. Neal, J. N. 1934. Proper Spacing and Depth of Tile Drains Determined by the Physical Properties of the Soil. Tech. Bul. 101, Agricultural Experiment Station, University of Minnesota, St. Paul, June, 1934.

3. Stephens, J. C. and H. A. Weaver. 1960. Relation of Evaporation to Potential Evapotranspiration at Fort Lauderdale, Florida. Paper No. 60-204, American Society of Agricultural Engineers, St. Joseph, Michigan. 1960.

4. Walker, Phelps. Depth and Spacing for Drain Laterals as Computed from Core-Sample Permeability Measurements. Agricultural Engineering Vol. 33. Pp. 71-73. February, 1952.

5. Rainfall Intensity-Duration-Frequency Curves for Selected Stations in the United States, Alaska, Hawaiian Islands, and Puerto Rico. Tech. Paper No. 25. U. S. Department Commerce, Washington, D. C. P. 10. December, 1955.

APPENDIX A

I. Imperfectly Drained Acid Soils with Hardpan
  - A. Leon Series
  - B. Immokalee Series
  - C. Pomello Series
  - D. St. Johns Series

II. Imperfectly Drained Acid Soils
  - A. Scranton Series
  - B. Ona Series
  - C. Kanapaha Series

III. Poorly Drained Acid Soils
  - A. Boyboro Series
  - B. Bladen Series
  - C. Coxville Series
  - D. Plummer Series
  - E. Portsmouth Series
  - F. Rains Series
  - G. Rutledge Series
  - H. Rex Series

IV. Poorly Drained Shallow Soils over Alkaline Materials
  - A. Arzell Series
  - B. Charlotte Series
  - C. Copeland Series
  - D. Delray Series
  - E. Felda Series
  - F. Manatee Series
  - G. Matrnon Series
  - H. Pompano Series

V. Imperfectly Drained Shallow Soils over Alkaline Materials
  - A. Adamsville Series
  - B. Bradenton Series
  - C. Broward Series
  - D. Keri Series
  - E. Panasoffkee Series
  - F. Parkwood Series
  - G. Ruskin Series
  - H. Sunniland Series

EFFECT OF FUNGICIDE DRENCHES APPLIED IN THE FURROW AT PLANTING TIME ON CONTROL OF DAMPING-OFF OF SNAP BEANS

P. L. THAYER
Assistant Plant Pathologist
Everglades Experiment Station
Belle Glade

and

H. Y. OZAKI
Assistant Horticulturist
Plantation Field Laboratory
Fort Lauderdale

Damping-off and root rots of snap beans in south Florida are caused principally by *Rhizoctonia solani* Kuhn and species of *Pythium*. The most obvious damage caused by these fungi occurs during germination and shortly thereafter in the form of damping-off. Later invasions usually result in lesions on the stem at the soil level or on the root system under the soil surface, and perhaps less frequently result in death of the plant by damping-off.

Loss of plants by damping-off has been reduced by the use of fungicides applied as drenches in the furrow at plant time (2,3,4,

Florida Agricultural Experiment Station Journal Series 1144.

5,6,7). A combination of pentachloronitrobenzene (PCNB) plus Captan applied in this manner has been suggested for farmers' use in Florida (1). If used properly, PCNB reduces plant loss caused by *R. solani*, and Captan reduces damage caused by *Pythium* spp. Despite damping-off control, workers in Florida have not been able to increase bean yields by use of in-the-furrow application of fungicides (2,3,7). Undoubtedly this can be partially explained by a tendency of individual bean plants to increase production of fruit as the plant stand is decreased. Previous work (7) also indicated that variability in the distribution of damping-off hampers accumulation of accurate yield data: thus only large differences could be significant.

In this investigation damping-off data were taken at four intervals during the entire life of the crop to determine what extent damping-off occurs at various ages of the bean plants and to establish the effective longevity of the fungicides.

Materials and Methods

Plots located at the Plantation Field Laboratory were arranged in a random block design with 5-25 ft. replications. There were two rows of beans planted on each bed, one treated and the other untreated, so that there was a check plot for every treated plot. The bean variety Contender was planted on October 14 at two inch intervals in the row. Fungicides were measured and mixed separately for each replication of each treatment. They were then applied with a hand sprayer in the following manner: two spray passes were made over bean seed in the opened furrow, then spray was applied to the soil as it was pulled in over the furrow, and finally two or three passes were made over the closed furrow. The fungicide treatments listed in Table 1 were applied in 20 gal. of water per acre. Fertilizer applications were made as needed and sprays were applied for control of foliar diseases and insect pests. The "t" test at the 0.05 level was used as a measure of significance between treated and paired untreated plots. No attempt was made to differentiate treatments.

Results

Six days following seeding 90 to 100 percent of the seeds had germinated and the plants had emerged. No differences could be detected in plant stand, indicating that little pre-emergence damping-off had occurred and that none of the treatments were phytotoxic. Post-emergence damping-off counts were taken four times during growth of the crop. Results are presented in Figs. 1 and 2.

In Fig. 1 the treated plots are compared with their paired untreated plots. Plots treated with D-113 plus Captan had less damping-off than the check during a period of two weeks following seeding. After this there was no significant difference between treated and un-

Table 1.--Fungicides used and rate of application.

Trade Name	Chemical name	Rate per 100 ft. of row
D113	50% 1,2-Dichloro-1-(methylsulfnyl) ethylene	16 gr.
Captan	50% N-Trichloromethylthiotetrahydrophthalimide	22 gr.
PCNB	75% Pentachloronitrobenzene	22 gr.
Panogen soil drench	3.5% methylmercury hydroxide	16 ml.
Quicksan	10% Chloromethoxy-propylmercuric acetate	24 ml.
Spergon	48% Tetrachloroquinone	44 gr.
SD 4741	70% O,O,O - Trimethyl phosphorothioate	45 ml.

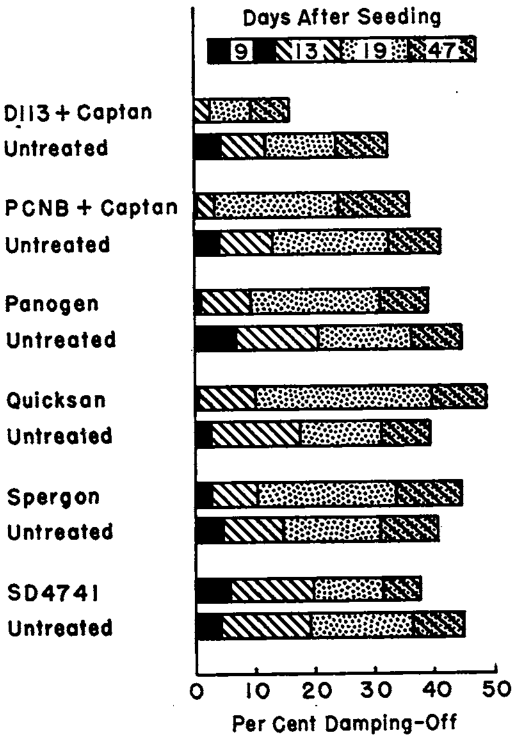

Fig. 1. Paired comparisons of per cent damping-off of snap beans following application of fungicides in the furrow at seeding vs. no fungicide treatment.

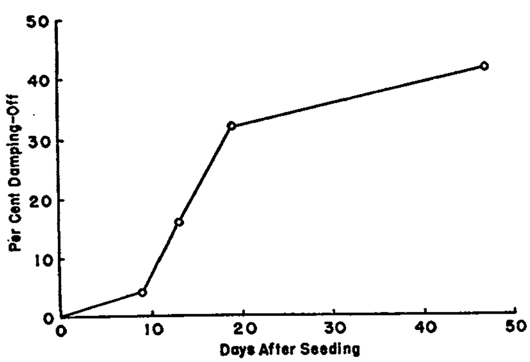

Fig. 2. Average cumulative per cent damping-off of the snap beans in untreated plots.

treated plots. However, plant stand at harvest was greater in D-113 plus Captan plots than the check. PCNB plus Captan also reduced damping-off for the first two weeks. This treatment did not result in a significant difference in final plant stand. Panogen soil drench reduced damping-off at the first sampling nine days after seeding but not thereafter and there was no significant difference in final plant stand. Quicksan reduced damping-off at the first sampling, increased damping-off between the first and second sampling, and had no measurable effect after that, so there was no significant difference in final plant stand. It is not known exactly what factors are involved in the results with Quicksan. It is possible that organisms which usually compete with the soil borne pathogens are inhibited more by this material than the pathogens, thus permitting a period of increased activity after a brief period of control. Spergon and SD 4741 had no measurable effect on damping-off.

The average percent damping-off for the six untreated plots is presented in Fig. 2. It is interesting to note that although most of the damping-off occurred during the first three weeks after planting, there was some plant loss during the entire growing period.

No yield differences could be detected as a result of any of the treatments, despite the increase in final plant stand by D113 plus Captan.

Discussion

Probably the most important single reason for not obtaining increased yields of beans by used of soil fungicides is the tendency of individual plants to increase in yield with decrease in plant stand. From the data of Burdine[1] in 1957 and of Hoffman[1] in 1947, on plant spacing in relation to bean yields, it was estimated that an increase in stand in treated plots of 50 percent, over the check, would be necessary to obtain a difference in yield. In this experiment all plots had less than 50 percent stand loss so presumably even perfect control would not have increased yields.

The best treatments in this test reduced damping-off for a period of two weeks following seeding, while damping-off continued at a high rate for three weeks. This resulted in far less than perfect control and is an additional factor in failure to obtain yield increase.

In view of these facts it seems desirable to obtain more information on the extent of damping-off over the entire growth span of bean crops. This would insure more intelligent recommendations to the farmer concerning chemical means of control and what could be expected from such treatments.

[1]Unpublished progress reports, Everglades Experiment Station.

SUMMARY

Fungicides were applied in the furrow at planting time to control damping-off of snap beans. There was no measurable pre-emergence damping-off. Post-emergence damping-off, determined by four counts during growth of the crop, occurred at a high rate for three weeks after seeding then continued at a reduced rate until harvest. D113 plus Captan and PCNB plus Captan reduced damping-off for two weeks following seeding. The former treatment resulted in a greater plant stand at harvest than the check but the latter did not. Quicksan and Panogen soil drench reduced damping-off for nine days after seeding but did not significantly affect final plant stand. Spergon and SD 4741 had no significant effect on damping-off. No yield differences could be detected.

ACKNOWLEDGEMENT

The authors wish to express thanks to Dr. H. I. Borders for aid in collection of the data used in this paper.

LITERATURE CITED

1. Brogdon, J. E., M. E. Marvel, and R. S. Mullin. 1960. Commercial vegetable insect and disease control guide. Fla. Agr. Extension Service Circular 193A pp. 31-32.

2. Conover, R. A. 1954. Damping-off and root rots of vegetable crops. Ann. Rpt. Fla. Agr. Exp. Sta. p. 286.

3. Darby, J. F. 1956. Control of damping-off and root rots of vegetable crops. Ann. rept. Fla. Agr. Exp. Sta. p. 153.

4. Kendrick, J. B., A. O. Paulus and J. Davidson. 1957. Control of Rhizoctonia stem canker of lima bean. Phytopathology (Abstr.) 47: 19.

5. Moore, W. D. 1954. Damping-off and root rots of vegetable crops. Ann. Rpt. Fla. Agr. Exp. Sta. pp. 248-249.

6. Moore, W. D. and R. A. Conover. 1955. Chemical soil treatments for the control of Rhizoctonia on snap beans. Plant Dis. Reptr. 39: 103-105.

7. Thayer, P. L. 1959. Evaluation of disease control chemicals applied to vegetable crops during the 1958-59 growing seasons. Everglades Sta. Mimeo Rept. 60-8.

Handling and Processing Section

IMPROVED HOUSEKEEPING IN CITRUS CONCENTRATE PLANTS

D. I. MURDOCK, CHARLES H. BROKAW AND A. G. MIKKELSEN

Minute Maid Corporation

Orlando

Sanitation of a food manufacturing process is an integral part of plant operation and embraces control of both microscopic and macroscopic contamination of all types. Good housekeeping implies cleanliness, tidiness, and freedom of refuse in all areas of operation. A clean plant means better working conditions for the employees, less chance for accidents, and improved efficiency and morale. Good or bad housekeeping is contagious. A sloppy plant creates sloppiness and carelessness among its workers. Throwing cigarette butts, food items, rags, and other debris on the floor which already contains this material becomes no concern of the employee. On the other hand, in a clean, tidy plant with spotless walls and floors, the average person will usually place these items in containers provided for this purpose. While a food process may be essentially sanitary the plant, itself, may be disorderly and have a poor appearance. Good housekeeping will not guarantee better process sanitation but experience has shown it will have a beneficial influence. Consequently, it is fairly well accepted that process sanitation and housekeeping should be considered as common objectives. In fact, they are often referred to under the single heading of sanitation.

Florida receives a large influx of tourists during the citrus season. Many of these people visit citrus plants and request to see them in operation. There can be no argument that the citrus industry has achieved recognition for a high degree of sanitation from the standpoint of process and products. But what visitors see, is most often connected with the outward aspects of sanitation or housekeeping. This sug-