RESEARCH ON BACTERIAL SOFT ROT OF IRISES

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INTRODUCTION

In August 1978, Region 24 initiated a research program to investigate the causes and control of bacterial soft rot in irises as a part of their Charlotte Sawyer Iris Research Project. An agreement was negotiated with Alabama A & M University to conduct this research program under a multiple year grant. This grant is jointly funded by Region 24 and the American Iris Society Foundation. The first phase of this program was to conduct an extensive literature survey to determine what was already known about this disease problem, not only in irises but also in other plants, and to determine promising research approaches to disease control. The second phase, which is in its infancy, was designed to conduct experiments to identify soft rot control strategies. This report summarizes progress made in both phases.

LITERATURE SURVEY

Bacterial soft rot of succulent plant tissue is of world-wide occurrence. It is one of the most important diseases of vegetable and ornamental plants in transit and storage, and is among the most important of the bacterial diseases of growing plants. Elliott (1930) lists the following plants as common hosts for bacterial soft rot: onion, celery, asparagus, many edible members of the cabbage family, caladium, red and green pepper, chicory, cucumber, muskmelon, carrot, Jerusalem artichoke, hyacinth, many species of irises, lettuce, tomato, tobacco, geranium, kidney bean, snap bean, rhubarb, egg plant, potato, and violets. As can be observed, this bacteria has a widespread host range among the economic plants.

The bacteria are common in most soil, particularly soils closely cropped with plants susceptable to attack. This disease is documented extensively in the United States, Canada, Bermuda, Great Britain, Holland, France, Japan, and the Philippines (Elliott, 1930). L. R. Jones in his studies at the Universities of Michigan and Vermont showed that the bacteria *E. carotovora* causes soft rot by producing an enzyme (Pectinase) that dissolves the cementing layer between cells,

therefore, tissues loose their form and structure. *Erwinia carotovora* (Jones) Holland is a peritrichously flagellate rod, 0.7 μ x 1.5 μ that forms white, somewhat roughened colonies in culture. In nature the bacterium survives from season to season in the soil deriving nourishment from plant debris (Roberts and Boothroyd, 1972).

Iris growers probably have had the experience of noting a wilted and drying fan on a clump and getting their fingers in a slimy, foul-smelling mess at the base of the plant when they started to investigate the disease symptoms which are actually the last stage of a fairly long process. This disease may appear immediately, soon after transplanting, or after clumps have been established. The first symptom observed is falling over of the healthy leaves because of the rot and tissue collapse at the base. The foul odor also provides a good means of diagnosis.

Soft rot is basically a hot weather disease progressing most rapidly at a temperature above 80°F. It probably would be of little or no importance below 60°F. The disease appears to be favored by the accumulation of moisture at the base of the plant (Dimock, 1959). Such climatic conditions are particularly prevalent in the southeastern U.S.

A positive identification of *E. carotovora* is only possible in the laboratory using microbiological techniques. Considerable work has been done on such isolation/identification techniques as selection media, fluorescent antibody stains, soil enrichment, and plant tissue screening.

Wills (1945), a Nashville, Tennessee iris grower, reported on conditions that are most conducive to soft rot incidence. He observed greater incidence of soft rot among irises from crosses involving reds and pinks, while those with blends in their parentage were presumably 'hardy' to the disease. A lesser association was seen between the level of liming and soft rot incidence. The soft rot started a few inches above the root and then spread downward into the rhizome.

Randolph (1949) suggests prevention of the spread by thorough garden cleanup. This simple management step consists of the removal and burning of dead leaves from irises and from surrounding shrubbery to prevent the spread of fungus leaf spot, bacterial soft rot, and the iris borer. He also stated that by 1949 the iris borer was found to be as far south as Nashville, Tennessee. A wider spread of borer was anticipated. The life cycle of the borer and the symptoms caused by it were also discussed. Dimock (1954) emphasized the importance of effective iris borer control along with good cultural practices such

as provision for water to drain away from the rhizomes and avoiding heavy application of manure, crowded growing conditions, planting under shade, and excessive weeds in the iris plots. Suberization or callousing of rhizomes prior to planting by exposure of fleshy rhizomes to sun or to dry cool air is also recommended as a preventative practice (Wallace, 1957). Howard (1962) conducted a study in West Virginia titled "The Iris Borer and Iris Soft Rot". The source of the disease is contaminated soil that is present on or in the vicinity of the iris plant. The borer becomes contaminated as it moves around over the foliage and then introduces the disease into the susceptible tissues during any subsequent feeding. The role of the borer in spreading iris soft rot is thought to be as follows: inflicting the wound necessary for the infection by soft rot, introduction of the disease into the wound, and breaking down or inhibiting the cork formation in rhizomes which would heal and prevent entrance of the disease. A preference of the borer moth for oviposition on dried flower stalks rather than on the leaves was also reported. Removal and destruction of iris stalks could be an effective preventive measure both for the iris borer as well as for soft rot.

Gaskill (1954) recommends certain soil fertility and physical environmental considerations for proper culture of irises. Deep, loose, friable soil which will supply moisture with minimum compaction is desired. A soil reasonably balanced in amounts of clay, sand, and humus meets the above physical requisites. Except for barnyard manure which contains weed seeds, other forms of humus are considered beneficial. Gaskill attributes soft rot incidence more to the injuries caused during the removal of weeds and grass than to the addition of manure or humus *per se*. For iris culture, the soil pH should be kept below 7.0. At lower pH *E. carotovora* should proliferate less rapidly in the soil.

The literature is replete with reports of various control measures/treatments which have seemingly provided some degree of control of soft rot. Many of these methods have been tried by other growers with mixed results leaving a question as to their effectiveness. A summary of the more predominant control measures mentioned in the literature as follows:

(1) Frequent examination of plants to detect borers is desirable. All rotted portions of the rhizomes should be carefully cut out and destroyed. The remaining rhizomes should be soaked in a disinfectant solution and then let dry in the sun before resetting (Dimock, 1954; Leach, 1965; Anonymus, 1966).

(2) Dusting or spraying the plants and surrounding soil, including exposed rhizomes, heavily with an insecticide for borer control. The application should be repeated every week until the flower spikes begin to show (Pirone and coworkers, 1960). Materials, such as rotenone, pyrethrum, Thimet, and Malathion have given good control on the young borer if applied weekly (Pirone, Dodge, Rickett, 1960). Dunbar (1975) also reports efficacy of Cygon, Dursban, Orthene, Isotox, and Diazinon.

(3) Since the bacteria that cause soft rot are highly susceptable to drying, shallow planting with the upper half of the rhizomes above the surface of the soil will aid considerably in preventing trouble. A well drained soil is desirable (Forsberg, 1975).

(4) Since several antibiotics have the property of controlling bacteria, iris growers began to experiment with their effectiveness for control of soft rot as early as 1954. Coffey (1956) used Agrimycin and Terramycin for control of soft rot. Upshur (1963) utilized Agrimycin 100 (Agricultural Sales Div. Pfizer & Co., Brooklyn, NY) which is a combination of Streptomycin and Terramycin and found that this product was more effective than Agri-Strep (Merck and Co.). Application of the antibiotic was made weekly using a watering can to soak the foliage, rhizome, and ground around the plants. Nash (1962) reported *E. carotovora's* sensitivity to Streptomycin and Triple-Sulfa. He sprayed on four occasions during the growing season with a mixture of Agri-Strep, detergent Dreft, with Dupont's sticker-spreader. The concentration of Agri-Strep in the spray mixture was 440 ppm. The control plot was also dusted with 10% sulfanilamide, 10% sulfapyridine, and 80% of dusting sulfur. Based on this one year study, effective control of soft rot was observed. Pirone (1978) also suggested Streptomycin dip as an effective control method at planting time. Dickinson and Einert (1974) have used Squibb Mysteclin F (1 capsule/gal.) as a preplant rhizome dip. Mysteclin F contains tetracycline hydrochloride and amphotericin B, a combination of bactericide and fungicide.

(5) On lettuce (crisp head type), weekly application of copper hydroxide or basic copper sulfate reduced soft rot incidence in Hawaii (Cho, 1977).

(6) Several household remedies have also been tried by iris growers. Their claims for effectiveness can be justified because of the disinfecting properties of certain household detergents and scouring agents such Clorox, Comet, Ajax, and Lysol, etc. Lowering of the soil pH using a mild organic acid such as vinegar has also been mentioned.

Based on previous reports, several approaches can be considered for iris bacterial soft rot control. Some of these are:

(a) The effect of bactericides (antibiotics) and the relative efficiency of various formulations available should be evaluated. The most effective chemicals in terms of cost, number of applications needed per season should also be considered. In this regard, experimental controlled-release antibiotics could be formulated and their effectiveness studied.

(b) The use of antibiotics could be augmented with effective insect control and also used in combination with some fungicides.

(c) Various methods of weed control including herbicides and mulching should be considered for minimizing repeated cultivation, thereby avoiding injury to plants.

(d) Studies need to be undertaken in relation to manipulation of the soil environment so that the soils in the vicinity of iris rhizomes become less suitable for soft rot bacteria growth. Manipulation of pH, improved drainage, and other soil requisites such as improved aeration should be methodically studied.

(e) A concentrated long term effort in identifying genetic resistance in irises to soft rot is needed. Utilization of such resistance in the breeding for soft rot rsistance in iris cultivars should be an important ingredient of soft rot control.

Several of the control measures suggested above were previously studied on non-replicated plots. In such cases the datea received minimum statistical treatment. It is clear that *E. carotovora* will be a difficult disease to control or prevent because of its wide host range and omnipresence in the ecosystem.

EXPERIMENTAL PROGRAM

The Research Committee of Region 24 and staff members of Alabama A&M University evaluated and discussed the results of the literature survey and planned an experimental program to investigate the causes and control of bacterial soft rot in irises. It was decided that the initial experimental program would be directed toward evaluation of various chemical and cultural treatments.

An experimental garden site was provided by Alabama A&M and bed construction was initiated in the fall of 1978. Three beds were prepared initially. Each bed is 210 feet long, 4 feet wide, and raised a minimum of 6 inches above the paths. Preparation included the addition of silt soil and fertilizer and rototilling. One of these three

beds was further prepared and utilized as discussed below for the first experiment. The other two beds were planted for display and stock multiplication. Two additional beds were added later and one was prepared for the pH experiment which would be initiated the following year.

Experiment No. 1 was intended to evaluate several of the control measures suggested in the literature survey. Treatments consisted of commercially available Agrimycin (antibiotic—dip 50 g/1, every two weeks), Furidan (systemic insecticide—sprinkle ½ tsp 1 inch off the rhizome, every 6 weeks), Fertilaid (a mixture of 37 Brazilian bacteria, some hopefully caniballistic to *E. carotovora*—initial surface application 5 lb/100 sq. feet), Dowfume (biocide—preplant soil treatment at the recommended rate of application), and a combination of Dowfume and TEMIK (granular systemic insecticide—applied every 6 weeks). Three iris varieties were selected, from the limited choices available in the quantities required, based on their soft rot susceptibility as determined by the growing experience of Schreiner's Gardens who graciously provided all of the 288 rhizomes for this experiment. The varieties selected were BABBLING BROOK, CRAFTSMAN, and MELODRAMA. The experiment was designed in a randomized complete block with four replications and four rhizomes per variety per replication. Observations consisted of the number of unrotted rhizomes and the number of fans produced per rhizome. During the winter of 1978-79 we encountered severe losses in the experiment bed which were not at all typical and were probably attributable to late planting which led to heaving. The experiment was replanted in 1979 and continued. We took this opportunity to make two changes in the experiment: (1) the bed was mulched with pine straw to prevent heaving and (2) Furidan, which has label restriction due to its extreme toxicity, was replaced by Cygon 2E (liquid systemic insecticide). Observations were made at regular intervals from the fall of 1979 until September 1980 when the complete experiment bed was dug and final data recorded. Although the problem of bacterial soft rot was far from resolved, the following conclusions are drawn:

1. The use of pine straw mulch during the winter months is of great value in protecting iris plants from heaving and subsequent damage. This confirmed the findings of Mississippi State University under the B. Y. Morrison Project sponsored by Region 24 and AIS in 1965-73 (Perry and Box, 1973).

2. The regular use of the systemic insecticide Cygon 2E appears to burn iris foliage.

3. There is a significant difference in resistance to bacterial soft rot between iris varieties. This suggests that control could be achieved in time by screening available varieties and breeding for disease resistance.

4. Generally, soft rot incidence seems to associate itself with the density of plants. Crowded rhizomes tend to hold water and stay moist longer, thus creating a favorable environment for the disease. The practice of dividing rhizomes needs to be more frequently followed for rapidly growing varieties.

5. Experimental data seem to indicate beneficial aspects of a systemic insecticide, such as Cygon, and an antibiotic, Agrimycin. Regular use of such compounds in iris culture merits further consideration.

Experiment No. 2 is intended to investigate the effect of soil pH on the incidence of bacterial soft rot. Soil pH is the primary environmental condition variable that affects the density and composition of soil bacteria. The greater the hydrogen ion concentration (lower pH), the smaller generally is the size of the bacterial population. This experiment will require two years of observations to determine whether low pH will control soft rot and whether the iris plants will grow and bloom satisfactorily in a low pH soil condition.

Planning is already underway for a third experiment which will be based on the results of the first experiment. Future reports will discuss this new experiment and provide the final results of the current experiments.

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