UNIVERSITY OF MINNESOTA

The North Central Quarterly

Published by the North Central Experiment Station

GRAND RAPIDS, MINNESOTA APRIL 1995 VOLUME 65, NO. 2

Late blight (Phytophthora infestans) infects Tomatoes at the North Central Experiment Station

Scott A. Enebak, Research Associate, and David K. Wildung, Horticulturist

A susceptible host, a pathogenic fungus and ideal weather conditions all came together in September, 1994, to cause the first occurrence of late blight at the North Central Experiment Station in over 25 years. Late blight, a common disease on both potatoes and tomatoes, is caused by the pathogen Phytophthora infestans, a fungus, that favors cool, moist conditions for growth. The fungus is found in nearly all areas of the world where potatoes and tomatoes are grown, but is most destructive in the eastern half of North America where weather conditions and large acreage of Solanaceous crops are grown. The fungus is capable of infecting the leaves, stems and fruit, and was responsible for causing the historic Irish potato famine in the mid 1800's. Disease symptoms on tomato appear as circular or irregular, pale-green, water-soaked lesions on the leaves, stems and fruits often where water from rain or dew accumulates (Figure 1). The lesions are often surrounded by a pale yellow to yellow green margin that will blend into healthy green tissue. As the fungus continues to grow the water-soaked lesions enlarge, coalesce and leaves eventually turn brown. A zone of white, downy fungal growth often appears within the lesions on the undersides of the leaves. At the tips of the fungal growth are the asexual reproductive spores (sporangia) which are spread via wind, rain, humans, machinery and animals to new plants. If cool (64-72 F), moist conditions occur, the fungus can grow up to 1/2 inch per day and can cause the complete destruction of all plants in a field within a week or two. On a commercial basis, control measures include the periodic use of protective fungicides (metalaxyl compounds) when weather conditions favor the growth of the pathogen as well as the use of resistant plant cultivars. Unfortunately, many of the most desirable cultivars are also the most susceptible to the fungus.

In 1994, a tomato cultivar trial had been established at the North Central Experiment Station to evaluate for earliness and large fruit. The trial consisted of 44 cultivars, replicated 2 times planted in a Rosy Sandy Loam soil. Seed was planted in the greenhouse on May 2, and plants were transplanted to the field on June 2. Rows were spaced 6 ft apart with plants spaced 3 ft apart in the row for a final plant density of 2420 tomato plants per acre. Although the tomato trial had not been designed to evaluate late blight resistance, the infection provided an excellent opportunity to identify differences in cultivar susceptibility. To do this, each plant (6 per cultivar x 2 replicates) was rated for infection based on the presence of water-soaked lesions with fungal growth. No infection was scored as 0, infection of leaves was scored as 1; infection of leaves and stems was scored as 2, and infection of leaves, stems and fruit was scored as 3. Numbers were averaged for each cultivar across both replicates.

Heavy, dense plant growth, normal heavy dews, cool fall temperatures (without a killing frost) as well as the excessive summer rains all contributed to ideal conditions for fungal growth last fall. Symptoms of the disease first appeared in the planting on September 20, 1994 in the northeast corner of the plot (Fig 2). By September 25 infection was moving rapidly across the planting. Because of the rapid fungal spread, heavy fungal infection and lateness of the growing season the study was terminated one week after the disease was first detected. Termination of the experiment was based on the need to reduce the amount of inoculum of P. infestans that would be able to overwinter in the planting. However, prior to termination, significant differences were noted between the two replicate blocks as well as among the cultivars within the blocks. Overall, the north block contained; 1) more infected individual tomato plants, and 2) higher infection rates per plant than the south block. The large differences between the two blocks with respect to the amount of fungal infection makes meaningful disease resistance ratings for all 44 cultivars difficult. For example, many of the tomato cultivars in the southern block "escaped" infection and their classification as either resistant or susceptible is in question.

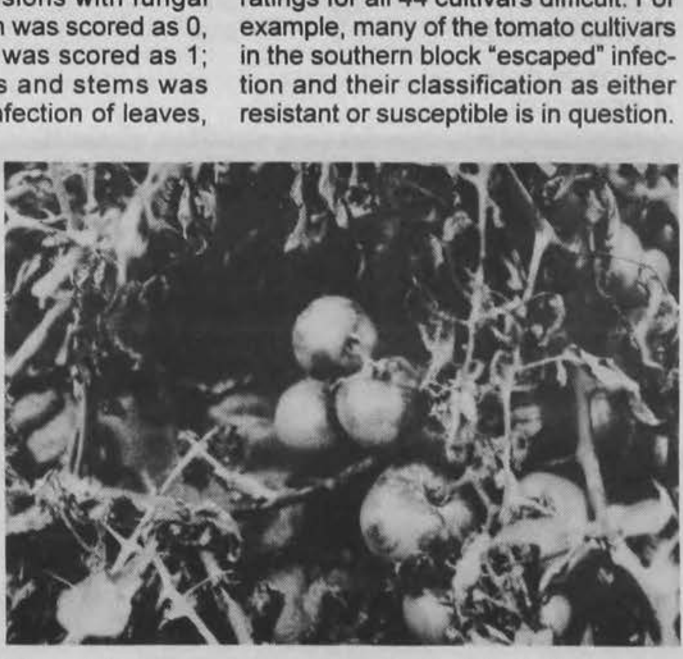

Figure 1. Disease symptoms on tomato infected with the pathogen Phytophthora infestans.

There were a number of cultivars in both blocks, however, that were consistently infected as well as a few cultivars that were consistently non-infected. Some of the more resistant and susceptible cultivars of the 44 examined are listed in Table 1.

Because of the relatively lateness of the season many of the cultivars had begun to mature and plant growth was declining. The resistant cultivars listed in Table 1 had an average maturity date nearly 7 days earlier than the susceptible cultivars, 9/15/94 vs 9/21/94, respectively. Therefore the lower amounts of infection observed on a few of the cultivars may be due to a lack of available leaf, stem and fruit area for infection, rather than specific resistance to the pathogen. Another factor that may have affected the amount of late blight infection on a few of the cultivars was the amount of early blight infection. Tomato plants within a cultivar with heavy early blight infection tended not to have as much leaf and stem tissue available for infection by P. infestans. The amount of late blight infection did appear to negatively correlate to the amount early blight infection as the resistant cultivars had, on average, more early blight infection than did the susceptible cultivars with 6.7 and 4.7, respectively (Table 1). It appears that both plant maturity and early blight infection may have had an affect on the rankings of cultivars with respect to their late blight infection rankings. Overall, there did not appear to be any among the 44 cultivars tested that were completely resistant to P. infestans. General fruit and plant ratings indicated that there were desirable cultivars in both susceptible and resistant groups.

The appearance of the disease in the two blocks and the spread of the fungus over time appeared to move from the northeast to the southwest and helps us pinpoint the probable source of the fungus. Two weeks prior to observing the fungus within the tomato trial, P. infestans was observed within potato plots, 1/4 mile northeast of the tomato plots. The fungus was later observed in another potato field 1/4 mile south of the tomato plots in late September which probably was infected from the tomato cultivar trial. It is not uncommon for the fungal spores to travel in air currents for several miles.

Figure 2. Relative amount of infection by Phytophthora infestans in the tomato cultivar trial. Plots E-H (north block) and plots A-D (south block) each contained the same 44 tomato cultivars. Infection rating, 0=no infection, 1=leaves infected, 2=leaves and stems infected, and 3=leaves, stems and fruit infected.

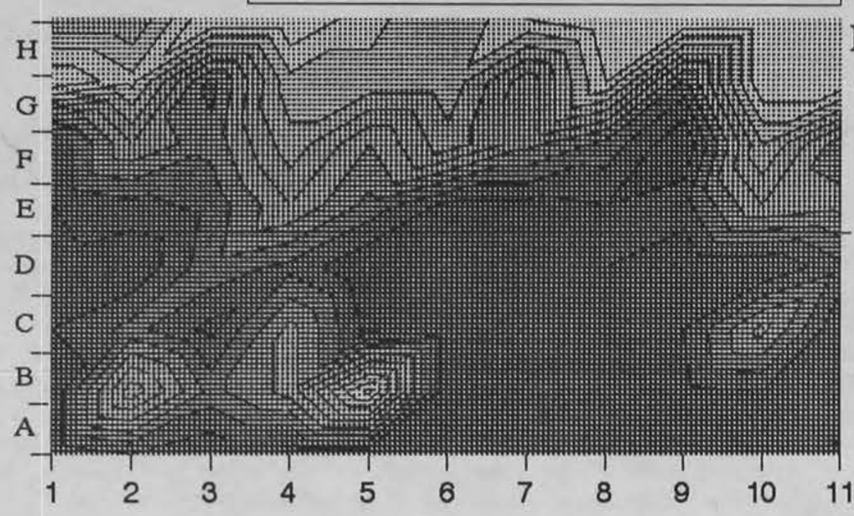

Table 1. Tomato characteristics of eight late blight susceptible and resistant cultivars planted at the North Central Experiment Station.

Cultivar	Late Blight Infection[1]	Maturity Date[2]	Source[3]	Early[4] blight Infection	Overall Plant & Fruits[5]
LATE BLIGHT SUSCEPTIBLE					
E 27077	2.9	9/16	EZ	8	5
XPH 10027	2.7	9/20	A/AS	6	7
FIRST PIK	2.4	9/23	H	6.5	6
STM 2102	2.3	9/25	SK	6	6.5
VALLEY GIRL	2.2	9/25	JS	7	6
SUNBEAM	2.2	9/25	A/AS	6.5	6.5
JACKPOT	2.0	9/16	FM	6	6.5
GOOD N'EARLY	2.0	9/20	BU	7.5	3
LATE BLIGHT RESISTANT					
NEW YORKER	0.4	9/01	H	4	6.5
FIRST LADY	0.4	9/12	LI	6.5	4.5
STM 2101	0.4	9/25	SK	5.5	6.5
OREGON STAR	0.3	9/16	NI	4	6
XPH 10028	0.2	9/20	A/AS	3	7
OREGON SPRING	0.2	9/10	JS	4.5	5.5
PILGRIM	0.2	9/20	AG	5	6.5
NORTHERN EXPOSURE	0.2	9/16	BU	4	6.5

[1]Infection rating, 0=no infection, 1=leaves infected, 2=leaves and stems infected, and 3=leaves, stems and fruit infected. Numbers are an average of 12 plants per cultivar.

[2]Date when one ripe fruit per plant was harvested.

[3]Source of material- A/AS=Asgrow, BU=Burpee, EZ=Enza Zaben, FM=Ferry Morse, H=Harris, JS=Jonnnys, LI=Liberty, NI=Nichols, SK=Sakata

[4]Early Blight infection; 1-3=severe, 4-6=moderate, 7-8=light, 9=none

[5]Ratings are based on plant height and width, disease incidence, maturity date, fruit shape & crax, green shoulders, locule number, flesh thickness, skin pressure, color rating and soluble solids; 1=least desirable, 9=most desirable.

Since this was the first time P. infestans had occurred in many years at the North Central Experiment Station attempts will be made to decrease the chance for future disease outbreaks. Last fall all the infected plant material was removed from the plots and spread out in order to freeze and kill the fungus over the winter. Eliminating the infected material and cull piles of tomato fruit or potato tubers should reduce the fungal inoculum that may spread back into an area the next summer. To further reduce the potential for infection from overwintering plant debris, a non-host plant will be sown into the infected section and future tomato plantings will be planted in another area this year. Finally, and out of our control, we hope that the Northern Minnesota will not experience similar climatic conditions that allowed the fungus to reach such epidemic levels that occurred last September.

Estrous Synchronization in Beef Cows

John Hall, Animal Scientist

Presently only about 5% of the beef cows in the US are bred by artificial insemination (AI). A limiting factor in adoption of AI by beef producers is the labor involved with estrus detection (checking heat). Use of AI will become increasingly important as the beef industry strives for more uniformity and quality in its product.

Estrous synchronization is a method to decrease the labor associated with estrus detection and make AI easier. Without estrous synchronization, producers would have to spend 21 days checking heat to have a chance of catching all the cows in the herd in heat. By using estrous synchronization, a beef producer can reduce that to 5 days.

Estrous synchronization techniques use injections of naturally occurring hormones or their analogs to bring all cows in heat. These compounds mimic what happens during the normal estrous cycle of the cow. The only difference is the events of the estrous cycles of all the cows to occur in a coordinated fashion as a result most or all of the cows to be in heat within a few days of one another.

Understanding the cows estrous cycle is important to using estrous synchronization effectively. The day the cow is in heat is day one of the 21-day estrous cycle. She stands to be mounted because of large amounts of estrogen produced by follicles on her ovaries. One follicle ruptures and releases the ovum (egg) which can then be fertilized. The ruptured follicle forms a corpus luteum or CL over the next 5 days. By 7 days after heat, the CL produces progesterone that keeps the cow out of heat and prepares the uterus for the pregnancy. The CL continues to produce of progesterone from day 7 to day 17 of the cycle. By day 17, the uterus produces large amounts of prostaglandin that lyses or kills the CL. This allows hormones from the brain to stimulate new follicles to grow from day 18 to 21. One follicle will produce the ovum for the next ovulation and the cycle starts over.

Currently there are 3 types of systems available for estrous synchronization in beef cattle. Prostaglandins, progestins and progestin/prostagladin combination. Prostaglandins (Lutalyse®, Bovaline®, Estrumate®) act by bringing cows into heat by killing the CL. These are given as injections and cows with a CL will come in heat 3 to 5 days after the injection. Synchromate B® supplies a progesterone analog in the form of an ear implant to keep cows out of heat until it is removed. The implant remains in place for 11 days then is removed. Cows come into heat 3 to 5 days after implant removal. Melengestrol Acetate (MGA) + prostaglandin uses a progesterone analog to group cows so they will respond more uniformly to the prostaglandin injection. MGA is fed for 14 days and prostaglandin is given 17 days after the last feeding of MGA.

All three products work very well on cows and replacement heifers. Two shot prostaglandin systems and Synchro-mate B tend to be more expensive than MGA + prostaglandin. The entire MGA + prostagladin system takes over 30 days while the others take about 11. There are many variations on each system that can alter cost, time spent checking heat, effectiveness and number of time cattle are worked. You should investigate these options to see which one works best for you. Estrous synchronization systems easily pay for themselves in increased calf value and decreased labor associated with AI. In addition, a shorter calving period and a more uniform calf crop will make herd management easier.

Remember an estrous synchronization program is not a replacement for good management, especially proper nutrition and herd health. In most cases, cows need to be at least 40 days post partum (after calving) and cycling for estrous synchronization systems to work.

Shift to Beef and Forage Continues

John Hall, Animal Scientist

This spring brings continued growth and change in the animal science activities at NCES. The research efforts will be refocused and expanded in the grazing ruminant area especially beef cow-calf research. Spring and summer activities will include pasture development, large scale grazing research and beef management systems.

The new barn at our South Farm is almost finished. We have had cows in drylot at that location since January. Although not research in the formal sense, this experience of developing a new research facility will also provide some practical information for beef producers. Experience is sometimes the best teacher; although, sometimes frustrating and costly. Hopefully we can pass on some of our experience in pasture development, drylot design and selection of working facilities through station tours.

Forage species selection, establishment and production is an integral part of our animal research program. In cooperation with Station Agronomist, Russ Mathison, and Extension Agronomist, Neal Martin, we are working to establish 60 new acres of pasture. Several species will be used in the pasture program so we can investigate carrying capacity, nutritional quality and persistence of different pasture forages. This summer we may include some intensive grazing of summer annuals in our program. In addition, will be comparing various methods of interseeding legumes into existing pastures. Lengthening the grazing season by using stockpiling or nontraditional forage species will be an important aspect of our forage program.

Intensive Rotational Grazing or Managed Intensive Grazing is a principal effort in our future research. Over the next two years we will begin grazing most of the cattle in a Managed Intensive Grazing system. The purpose of this research is to develop grazing and management strategies to improve animal productivity and health while decreasing input costs.

Another facet of the animal research program is cow-calf management techniques and technologies. Cow wintering systems, month of calving, early weaning, creep feeding, creep grazing and heifer development are some of the management decisions we may investigate in the coming years. In addition to asking the question "Will this increase animal productivity?", we are going to ask "How will this effect profitability?" An important part of the cattle research at NCES will be looking at new technologies from an Integrated Resource Management (IRM) standpoint. In essence how does adoption of a new technology in the cattle operation impact the entire operation from labor to feed resources to records to income.

As you can see, we have many research projects to keep us occupied. However, I am always looking for producers willing to cooperate with on farm research. Please feel free to bring a group for a tour this summer.

News from North Central

David L. Rabas, Head

As you can tell by the articles in the Quarterly, John Hall, our beef cow-calf research scientist has arrived and is hard at work. This is calving time for us and for many beef producers and therefore involves many long days and nights. Hopefully by the time the Quarterly is published and mailed Dr. Hall will have had a chance to visit with a few of our readers who are beef producers. He is looking forward to meeting with as many cow-calf producers as possible this summer and at our fall forage and livestock field day.

As I write this newsletter early in April, winter is trying hard to hang on as long as possible. Hopefully by the time you receive it spring field work will be well underway. Spring will bring with it a number of changes at NCES. One of the changes that I mentioned in the last Quarterly was the retirement of our long time secretary and Quarterly editor, Carolyn Frings. Carolyn and her husband Richard have been in Florida basking in 80+ degree temperatures. Carolyn has agreed to come back and see that this issue of the Quarterly gets out on time. Carolyn deserves to be recognized for the great job she has done of organizing, editing and mailing the Quarterly for many years. I'm sure if some of our Quarterly readers want to write to Carolyn to say thank you, she will be happy to receive your letters. Additional staff or job changes will also be occurring in the animal care and farm crew areas. I look forward to introducing a Senior Secretary and Assistant Farm Animal Attendant in our next issue of the Quarterly.

Carolyn Frings, Executive Secretary

April 1995 marks the 99th year since the North Central Experiment Station was established. We will begin the planning process for our July 1996 celebration of our centennial early this fall. Readers who have ideas or suggestions for centennial activities or who want to serve on the centennial committee should contact us soon.

The North Central Quarterly
Issued by
THE UNIVERSITY OF MINNESOTA
North Central Experiment Station
1861 Hwy. 169 East
Grand Rapids, Minnesota 55744-3396
218-327-4490
DR. DAVID L. RABAS
Head
Published February, April, July, November
ISSN 0199-6347
by the North Central
Experiment Station
Grand Rapids, Minnesota
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Second-class postage paid at Grand Rapids, Minnesota

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