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OHIO W-R GLOBE

A New Wilt-Resistant Glasshouse Tomato Variety

OHIO AGRICULTURAL EXPERIMENT STATION
WOOSTER, OHIO

CONTENTS

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INTRODUCTION

Fusarium wilt has been one of the most serious diseases of glass-house-grown tomatoes for many years. The destruction which may be brought about by this disease is shown in Figure 1. More research work has been directed toward the control of this disease than some other tomato diseases. Efforts to control the disease have included studies on the biology of the pathogen, environmental conditions which favor its development, and the breeding of resistant varieties. The last mentioned phase has received the most attention and many experiment stations have developed varieties partially resistant or tolerant to Fusarium wilt.

The type of resistance which occurs in the wilt-tolerant varieties is sufficient to largely protect them out-of-doors but it is not sufficient to protect them when grown under glass. Soil sterilization is therefore necessary, and steam sterilization with permanently buried tile has given the best results. However, soil sterilization is usually only partially effective because of the difficulties encountered in evenly heating a large mass of soil. Some of the reasons for uneven heating are excessively moist or dry spots, broken and clogged tile, tile too deep from additions of soil amendments and the packing of soil around the joints, thus prohibiting proper escape of steam. Two other disadvantages are the difficulty of obtaining a good fruit set following sterilization and the toxic condition of the soil which frequently results from excessive sterilization to control Fusarium wilt.

Because of the need for a better type of resistance, a program was started to develop a variety with the immunity type of wilt resistance described by Bohn and Tucker (4). Progress reports on this program have been made by Alexander (1,2).

HISTORY OF RESISTANCE

Early attempts to develop resistant varieties centered around the production of those which were less susceptible or tolerant to the disease. The source of this resistance came from the selection of resistant plants in fields where Fusarium wilt was especially severe. Two such varieties,

Figure 1.—Typical destruction caused by Fusarium wilt in unsterilized glasshouses.

Marvel and Louisiana Wilt Resistant, were used as resistant parents in breeding programs. Marvel originated from a single plant selection of the resistant French variety, Merveille des Marches, and was introduced by the United States Department of Agriculture about 1918. Louisiana Wilt Resistant resulted as a selection from Acme and was introduced by Edgerton and Moreland (6) of the Louisiana Experiment Station

about 1914. This was one of the earliest varieties developed as a result of a breeding program. These varieties and others developed from them assured the production of tomatoes in areas where Fusarium wilt had practically eliminated tomato culture.

More recently, Bohn and Tucker (4), 1940, announced the discovery of an accession of the wild Currant tomato, *Lycopersicon pimpinellifolium* Mill. which was immune to the Fusarium wilt organism, *Fusarium oxysporum f. Lycopersici* (Sacc.) Snyder and Hansen. Drs. Bohn and Tucker offered seed of the original resistant accession, designated as Missouri Accession 160, as well as advanced breeding lines, to others interested in tomato breeding work. These were secured and tested for resistance to the isolates of the Fusarium wilt fungus in Ohio. The results secured did not support the work of Bohn and Tucker (4). In subsequent exchanges of hybrids and cultures of the pathogen it was discovered that physiologic races of the pathogen existed. One of the isolates used at the Ohio Agricultural Experiment Station proved to be a new physiologic race. A report of this work was published by Alexander and Tucker (3).

So far as known, however, the new race of the pathogen — race 2 — has a very limited distribution and has been found in only one glasshouse in the Cleveland, Ohio, area. Consequently, when the advanced generations of the material secured from Bohn and Tucker were inoculated with race 1 of the pathogen and tested under commercial glasshouse conditions no disease occurred.

PARENTS AND THEIR DESCRIPTION

The resistant parent of Ohio W-R Globe is the Missouri Accession 160 of the species *Lycopersicon pimpinellifolium* Mill. Of the many introductions of this species tested for resistance to Fusarium wilt, only this one accession possessed a gene for resistance which conferred an immunity type of resistance and in which resistance was dominant and inherited according to a simple dominant Mendelian ratio. Of the 6 species of Lycopersicon, Muller (9), *L. pimpinellifolium* is most closely related to the domestic species, *L. esculentum*. The two species produce red fruits and have similar habits of growth. *L. pimpinellifolium* is probably a native of Peru, although it is found over a wide variety of climates. It is cultivated to some extent as an oddity and for ornamental purposes. It is known in the seed trade as the Currant tomato. The fruits are typically 2-celled, smooth, spherical, and slightly less than one-half inch in diameter.

Several varieties of the domestic species were used in developing fruit size and desirable market qualities. However, Livingstone Globe, and some of the Ohio Station's selections of it were used as the best glasshouse type. The fruit of Globe is pink colored, large, multiple celled, and typically globular, with a tendency to be smooth.

PEDIGREE OF OHIO W-R GLOBE

Ohio W-R Globe originated from crossing *Lycopersicon pimpinellifolium,* Missouri Accession 160, with several varieties of the domestic species in succession. The first crosses were made at the Missouri Experiment Station. Twenty-five advanced wilt resistant breeding lines were secured. From these, several were selected as breeding material for further crossing. Finally, the progeny of one of these lines, designated as M-8, was selected for further crossing. The pedigree of M-8-2 is as follows: Earliana x *Lycopersicon pimpinellifolium* (Missouri Accession 160) x Break O'Day x Break O'Day x Ponderosa, field selfed, x Greater Baltimore, and field selfed twice.

In order to produce a Globe type plant, three crosses were made to Globe or its derivatives and are as follows: Livingston Globe x M-8-2 x Association Globe x Selection A Globe, field selfed twice, glasshouse selfed once, and bulk selected 3 times. Selection A Globe is a superior type of Globe, isolated by Hoffman (7), and has largely replaced other

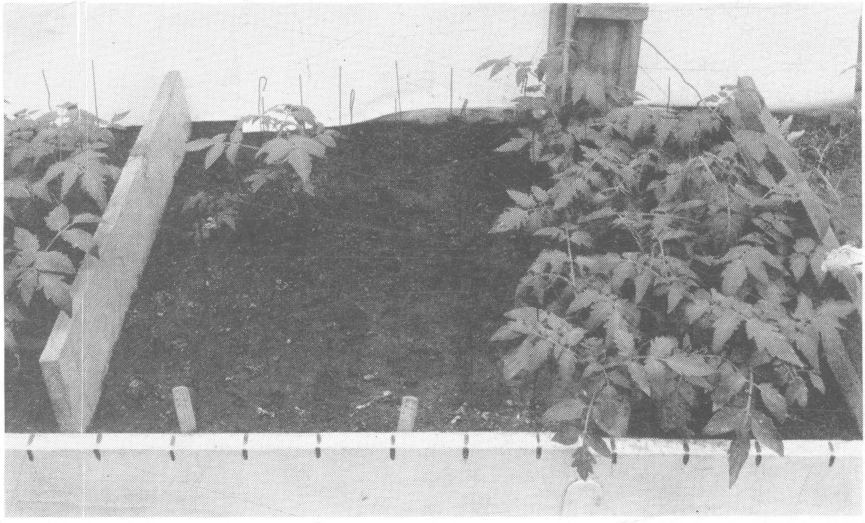

Figure 2.—The reaction of a susceptible progeny (left), Bonny Best (center), and a segregating progeny (right) to race 1 of the Fusarium wilt organism.

globe types for glasshouse culture. Descriptions of the other varieties used as parents have been published by Boswell et al. (5) and by Morrison (8).

Between each cross it was necessary to artifically inoculate the plants with pure cultures of the wilt organism and use only those plants that were resistant for further breeding work. An illustration of a wilt test is shown in Figure 2.

DESCRIPTION OF OHIO W-R GLOBE

Ohio W-R Globe has been developed especially as a wilt resistant tomato variety for glasshouse forcing in Ohio. No attempts have been made to test its adaptability elsewhere except as it has been observed in the field breeding and the seed multiplication plots. The description given is based on its growth characteristics in glasshouses.

Ohio W-R Globe should be classed as a midseason variety. Globe is listed by Boswell, et al. (5) as requiring from 70 to 80 days from transplanting to maturity. In commercial glasshouses, Ohio W-R Globe is slightly earlier, possibly 5 days, than Strain A Globe. The size of the plant is large and the habit of growth is indeterminate. It is easily pruned to a single stalk and trained up a string in commercial glasshouses. The growth is vigorous but probably slightly less so than Globe.

The amount of foliage is comparable to that of Globe. When grown out-of-doors, either staked or unstaked, sun burning may occur. In glasshouses this trouble does not occur except where the vines are trained along the wires and the fruits are unduly exposed. The leaves are large, but vary from slightly narrow to broad, depending upon environment. The color of the foliage is light.

The size, shape, and number of fruits per cluster vary considerably with the rapidity with which the plant is growing as well as with the cluster. The fruit on the first cluster on highly vegetative plants tends to be large and flat. As plants advance farther the fruits are large and typically globular. (See Figure 3.) The polar diameter, however, is somewhat less than the equatorial diameter. Ohio W-R Globe produces some of the extremely large very meaty fruits. These large fruits vary in shape from circular to oblong and usually are many celled. In general, the fruit of Ohio W-R Globe is slightly smaller than that of Globe. The number of fruits per cluster varies greatly but under glasshouse conditions is typically 4-

The color of the fruit when fully ripe is scarlet red. However, in the immature stage in which hothouse tomatoes are picked the color is pink. The variety is known as a pink type because of a colorless skin.

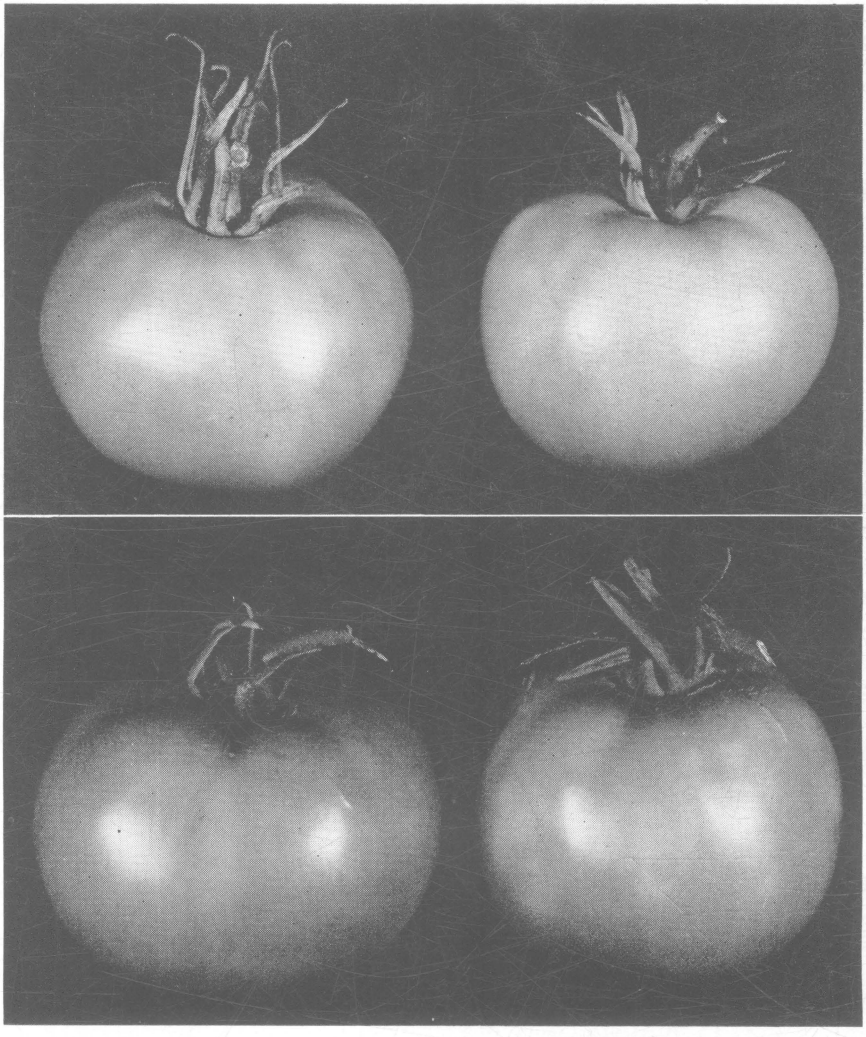

Figure 3.—Comparison of mature whole fruits of Ohio W-R Globe (upper) and Strain A Globe (lower).

The quality of the fruit is excellent with solid thick walls. (See Figure 4.) The number of cells varies from 5-6 but may be as few as 4, and in large irregular shaped fruits there are many cells. The firmness of the fruit appears good and it is thought to be somewhat superior to Globe. The evidence thus far obtained indicates good shipping qualities.

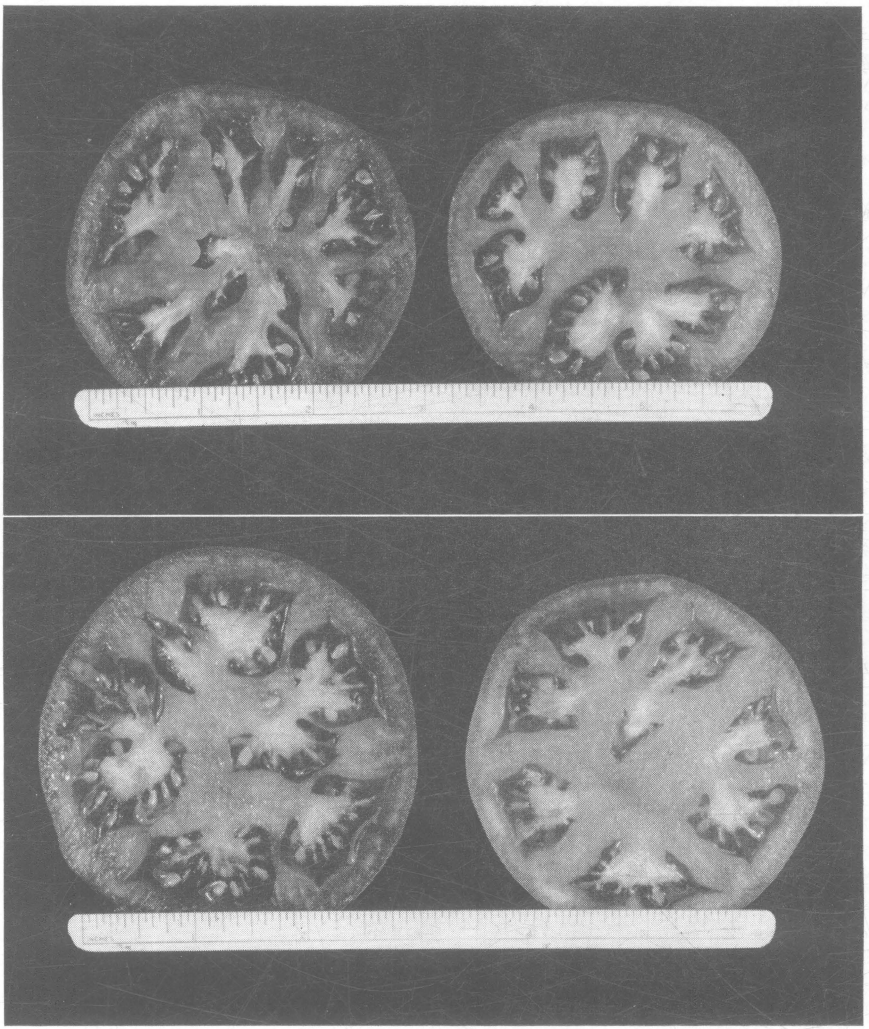

Figure 4.—Comparison of mature half fruits of Ohio W-R Globe (upper) and Strain A Globe (lower).

YIELD AND MATURITY OF OHIO W-R GLOBE

The data thus far obtained indicate that the yield of Ohio W-R Globe is equal to that of Globe where wilt is not a problem, but where Fusarium wilt is a problem, W-R Globe is superior. The yield data presented have been secured from cooperative commercial glasshouse

growers. In general, these data do not represent replicated yield plots but were secured in each case from plantings of the varieties in adjacent houses or rows. The number of plants used as a yield test varied but was always two rows the length of the glasshouse. Thus the number of plants per plot varied from as few as 100 to as many as 1000. The fruit per plot was weighed in most cases, but because the records were kept by the commercial men the number of uniformly filled baskets per plot was used in some cases. It had been found by trial that if fruit is picked in standard 8-quart baskets and a number of baskets are filled uniformly, the average weight is 10 pounds. Also, that the average weight of 10 pounds per basket, multiplied by the number of baskets will be approximately the total weight of the tomatoes if accurately weighed. The yield records secured were converted to pounds per plant and eight pound baskets per acre.

From the many breeding lines the best five were used for yield trials. In the first test, the yields of the five were all good, but selections 2 and 4 were discarded because of undesirable fruit characters. Selections 1, 3, and 5 were continued. However, selection 3 was finally chosen as the most desirable of the three because of its wider adaptability. The yield data show comparisons of it and Strain A Globe.

In the fall of 1945, the first yield test was conducted at the Paul B. Ruetenik glasshouses at Vermilion, Ohio. Fall crops are not as productive as spring crops because of increasingly shorter days and the many overcast days of November and December. In general, yields in fall crops are between 40 and 50 percent of spring crops. The results of this test are shown in Table 1.

Table 1. Comparative Yields of Ohio W-R Globe and Strain A Globe. Glasshouses of Paul B. Ruetenik, Vermilion, Ohio. Fall crop, 1945.

Variety	Pounds per plant	8-pound baskets No. per acre	% increase over Globe
Strain A Globe	6.0	5,680	....
Ohio W-R Globe	6.6	6,180	8.8

The fall crop in the houses in which these tests were conducted was excellent as shown by the fact that Strain A Globe exceeded 5,000 baskets per acre. Despite the fact that Strain A Globe produced an excellent crop, Ohio W-R Globe exceeded it by 8.8 percent.

The following spring, 1946, a yield test was again conducted in the same glasshouses. The results are shown in Table 2.

Table 2. Comparative yields of Ohio W-R Globe and Strain A Globe. Glasshouses of Paul B. Ruetenik, Vermilion, Ohio Spring crop, 1946

Variety	Pounds per plant	8-pound baskets No. per acre	% increase over Globe
Strain A Globe	7.4	8,403	
Ohio W-R Globe	9.6	10,881	29 5

In this test the yield of Strain A Globe was low. However, the yield of Ohio W-R Globe was nearly 11,000, 8-pound baskets per acre which is a good yield.

Under the conditions of these two trials, Ohio W-R Globe exceeded the yield of the standard variety, Strain A Globe. In both instances Fusarium wilt was present only to the extent that an occasional Globe plant was diseased.

The accumulative picking records for the fall crop of 1945 are shown in Figure 5 and for the spring crop of 1946 in Figure 6. In the fall of 1945, Ohio W-R Globe produced ripe fruit one week earlier than Strain A Globe and in each ensuing week was ahead. In the spring of 1946, both varieties produced ripe fruit the same week. During the first three weeks, Strain A Globe produced more ripe fruit than Ohio W-R Globe, however, from the fourth week on Ohio W-R Globe produced the heavier crop.

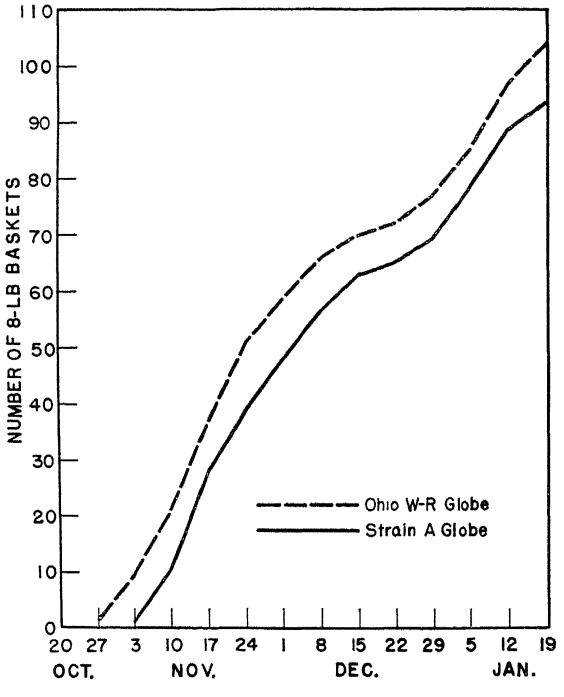

Figure 5. — Accumulative yield in 8-lb. baskets of Ohio W-R Globe and Strain A Globe. Paul B. Ruetenik Glasshouses. Fall crop, 1945.

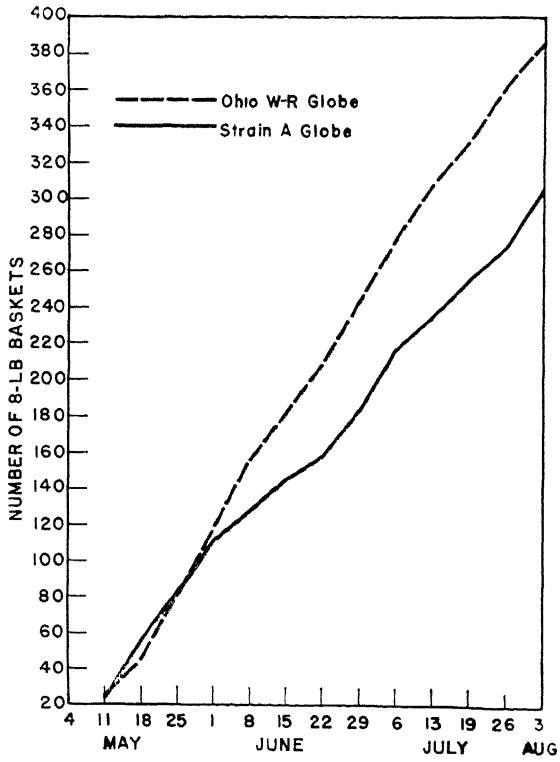

Figure 6. — Accumulative yields in 8-lb. baskets of Ohio W-R Globe and Strain A Globe. Paul B. Ruetenik Glasshouses. Spring crop, 1946.

In the spring of 1947, seed of Ohio W-R Globe was distributed to 100 growers throughout the state. Many kept partial records but only seven kept complete yield records. The yield records from these seven trials are summarized in Table 3 and Figure 7.

In five of the trials, Ohio W-R Globe exceeded Strain A Globe and in two it did not. (See Table 3.) The average for all trials was a 3.95 percent increase. In the case of the test at the Geo. Christensen's glasshouses, wilt was a problem in Strain A Globe. The average accumulative yields of two early crops and two late crops are plotted in Figure 7. In the case of the two early crops, Strain A Globe produced ripe fruit one week earlier and continued to out-produce Ohio W-R Globe for the next 12 weeks. The final yield for Ohio W-R Globe was greater than Strain A Globe, but it was not until the last 3 weeks that Ohio W-R Globe exceeded Strain A Globe. In the case of the two medium crops, both varieties produced ripe fruit the same week, but Ohio W-R produced slightly more. This advantage was maintained throughout the season.

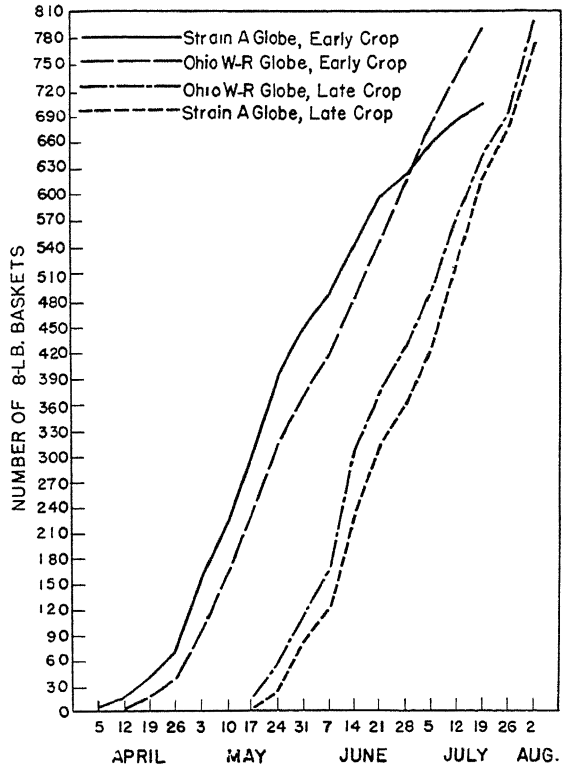

Figure 7.—Average accumulative yields from two early crops and two late crops of Ohio W-R Globe and Strain A Globe. Spring crop, 1947.

Table 3. Comparative Yields of Ohio W-R Globe and Strain A Globe at Several Glasshouses in Northern Ohio Spring Crop, 1947.

Cooperators	Strain A Globe		Ohio W-R Globe		Percent increase or decrease over Strain A Globe
	Pounds per plant	Baskets per acre	Pounds per plant	Baskets per acre	
Kraushaar Bros.	14.13	17,097	14.67	17,751	+ 3.8
Martin & Son	8.92	9,251	9.25	9,593	+ 3 7
Paul B. Ruetenik	11.39	12,406	10.25	11,161	−10.0
Wagner Bros.	9.72	10,581	9.45	10,291	− 2.8
H. Petersen	9.98	9,723	10.67	10,394	+ 7.0
Geo. Christensen	6.75	7,546	9.16	10,244	+35.7
Berea Greenhouse Co.	9.36	11,583	9.57	11,847	+ 2.3
Totals	70.25	78,187	73.02	81,281	
Average	10.036	11,170	10.431	11,612	+ 3.95

A yield test for the fall crop of 1947 was again conducted in the glasshouses of Paul B. Ruetenik. The results are shown in Table 4.

Table 4. Comparative yields of Ohio W-R Globe and Strain A Globe. Glasshouses of Paul B. Ruetenik, Vermilion, Ohio. Fall crop, 1947.

Variety	Pounds per plant	8-pound baskets No. per acre	Percent decrease
Strain A Globe	3.57	2,770.4	...
Ohio W-R Globe	3.47	2,534 1	2.7

The yield of both varieties was low in this test with Strain A Globe outyielding Ohio W-R Globe by 2.7 percent.

A third comparison of yield of spring grown crops was conducted in 1948. In this test three commercial men cooperated. The results of the test are shown in Table 5.

Table 5. Comparative Yields of Ohio W-R Globe and Strain A Globe. Spring crop, 1948.

Cooperators	Strain A Globe		Ohio W-R Globe		Percent increase or decrease over Strain A Globe
	Pounds per plant	Baskets per acre	Pounds per plant	Baskets per acre	
Berea Greenhouse Co.	10.34	12,920	11.67	14,590	+12.9
Geo. Christensen	9.06	10,993	10.61	12,836	+16.8
Paul B. Ruetenik	9.64	10,930	10.83	12,282	+12.4

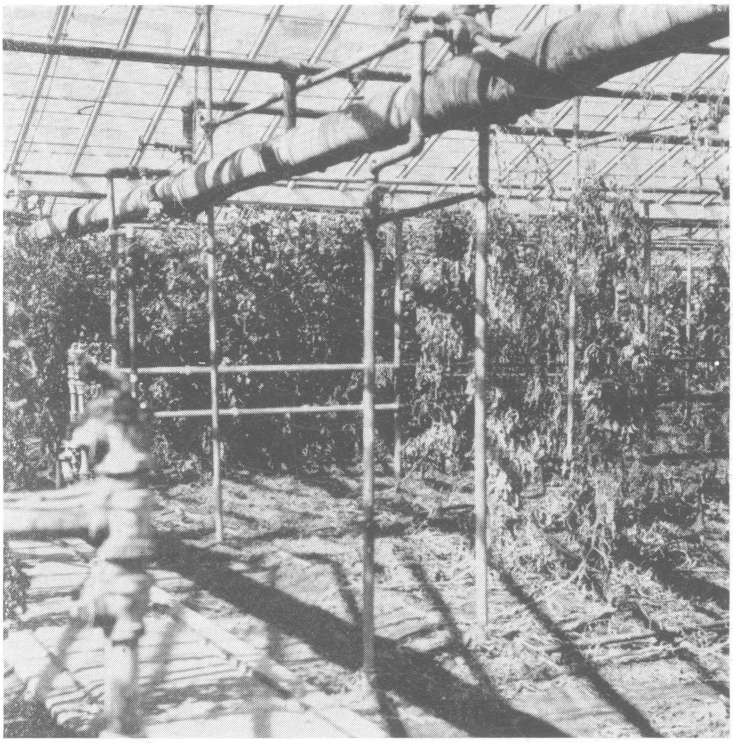

Figure 8.—Severe wilt loss on Strain A Globe in foreground. Upper left background wilt-resistant selection No. 5.

In these instances wilt was not a problem, yet Ohio W-R Globe exceeded the yield of Strain A Globe.

ADAPTABILITY OF OHIO W-R GLOBE

Ohio W-R Globe has been extensively tried in many locations throughout the glasshouse region of northern Ohio. In most instances it has yielded as well or better than Strain A Globe and in some cases, where wilt was severe, far surpassed Strain A Globe. In a few instances, Ohio W-R Globe did not yield as well as Strain A Globe, but the average of all the tests for the four growing seasons is greater than that of Globe. The data indicate that Ohio W-R Globe has a wide range of adaptability.

FUSARIUM WILT RESISTANCE

Ohio W-R Globe is highly resistant to the widely distributed form of the Fusarium wilt disease. The degree of resistance is illustrated in Figure 8. Strain A Globe, foreground, has been almost eliminated whereas the resistant selection No. 5 shows complete resistance. However, a new form of the Fusarium wilt organism has been discovered. Different forms of the disease-producing organisms are called races. Up to the present time, only two races of the Fusarium wilt organism have been distinguished. They are the old race, race 1, which is world-wide in its distribution, and the newly discovered race, race 2, which has so far been found in only one area near Cleveland, Ohio. The difference between pathogenicity of the two races of the pathogen is illustrated in Figure 9 and Table 6. In both instances it is shown that lines may be highly resistant to race 1 and highly susceptible to race 2.

Ohio W-R Globe is highly susceptible to race 2. It, therefore, can be expected that Ohio W-R Globe will not be valuable as a resistant variety in a few locations.

Table 6. Reaction of Selections from a Segregating Progeny to the two Physiologic Races of the Fusarium Wilt Organism.

Entry	Race 1		Race 2	
	Healthy	Diseased	Healthy	Diseased
	No.	No.	No.	No.
1	24	6	0	30
2	28	0	2	28
3	29	0	1	28
4	29	0	0	30
5	29	1	1	27
6	27	0	0	31
7	28	2	7	17
Bonny Best	0	30	0	29

Figure 9. Wilt reaction of a number of breeding lines to race 1 of the Fusarium wilt fungus (right), and the wilt reaction of the same lines to race 2, (left).

RESISTANCE TO OTHER DISEASES

Ohio W-R Globe is not resistant to any of the other diseases which attack glasshouse-grown tomatoes. Verticillium wilt is often confused with Fusarium wilt but even though both diseases are characterized by wilting, the causal organism is different and Ohio W-R Globe has no resistance to this disease.

Inquiries have also reached the writer about resistance to leaf mold, the virus diseases, nematodes, and damping-off. Ohio W-R Globe is not resistant to any of these.

ORIGIN OF NAME

The name, Ohio W-R Globe, resulted from an attempt to identify the variety as originating in Ohio and to indicate that it was of Globe type. In order to distinguish it from other Globe accessions and to indicate its disease resistant character, Wilt Resistance was added. This latter part was abbreviated to W-R for brevity.

CONTINUED NEED FOR SOIL STERILIZATION

Ohio W-R Globe will serve its greatest usefulness for those growers of glasshouse crops who have trouble with Fusarium wilt following steam sterilization. Fusarium wilt is the most difficult of the soil-borne diseases to eliminate and in many instances excessive sterilization is necessary to control it. The other diseases are fairly readily controlled by sterilization.

However, they must be controlled; hence, soil sterilization must be continued. This practice is also likely to help prevent the spread and development of the new race of the Fusarium wilt organism to which Ohio W-R Globe is susceptible.

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SUMMARY

A new tomato variety of Globe type has been developed which is resistant to the common form of the Fusarium wilt disease.

This tomato variety has been named Ohio Wilt-Resistant Globe.

The average yield of the Ohio W-R Globe equals that of the standard variety, Strain A Globe.

The vine and fruit characteristics of Ohio W-R Globe are similar to Strain A Globe.

Ohio W-R Globe is not resistant to the new race of the Fusarium wilt organism nor is it resistant to any of the other diseases of glasshouse-grown tomatoes.

Ohio W-R Globe appears to be slightly earlier than Strain A Globe.