

INCORPORATING POWDERY MILDEW RESISTANCE  
INTO A WINTER TYPE MUSKMELON

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### III

#### INTRODUCTION

This study grew out of a current research project at the Virginia Agricultural Experiment Station which is attempting to determine the commercial possibilities of a winter type muskmelon for Virginia.

The melon which was responsible for the instigation of this research project was the Ambrosia melon selected from a series of random crosses by a commercial grower, Mr. Louis Promos of Leesburg, Virginia. The Ambrosia melon has merit in that it has an exceptionally tough rind or skin which is a commercially valuable trait for fruit shipped to distant markets. In addition, some of the Ambrosia melon fruits have percentages of soluble solids (mostly sugars) which compare favorably with the Honeydew melon produced in quantity by growers in the western United States.

Externally the fruit is a large, oblate oval in shape, orange in color, tough-skinned and not netted but profusely marked with longitudinal corrugations. The flesh is thick, greenish-white in color, juicy, sweet and of good flavor.

These experiments have two objectives, namely: a) to incorporate resistance to the powdery mildew fungus, Erysiphe cichoracearum DC, to which the Ambrosia melon is very susceptible, into winter type muskmelons and; b) to study the manner of inheritance of resistance to the powdery mildew fungus in selected strains of the muskmelon, Cucumis melo.

All plants used in these experiments were started from seed in the greenhouses on the campus at Virginia Polytechnic Institute. All plants

grown to maturity in greenhouses were grown at Blacksburg. Field experiments were conducted at Blacksburg and Warsaw, Virginia.

## REVIEW OF LITERATURE

### Sources of Resistance to the Powdery Mildew Fungus

#### In Cucumis melo L.

There are available to the experimenter two sources of resistance to the powdery mildew fungus.

The first is to be found in commercial melons which have been developed specifically for use in areas heavily infected with powdery mildew. This source was not used in these experiments since the commercially available powdery mildew resistant muskmelons are of the botanical variety reticulatus or cantalupensis. The melon used in this study is of the variety inodorus (2).

The second available source is to be found in selections brought into the United States by the Plant Exploration and Introduction service of the United States Department of Agriculture. This is the source utilized in this study. Presumably, resistant strains from this source have been subjected to centuries of natural selection and so should represent the best possible source of disease resistant material (14).

### Methods Used in Melon Breeding

#### Specific Techniques

Greenhouse: Melons grown in greenhouses may be subjected to controlled environmental conditions and are usually readily accessible for breeding work.

The muskmelon, Cucumis melo, is found in both the monoecious (having staminate and pistillate flowers) and andromonoecious (having staminate and perfect flowers) conditions. For varieties exhibiting the monoecious condition, breeding work is comparatively simple in that the experimenter need only pollinate the desired blossoms without fear of natural self-pollination occurring. If insect vectors are excluded there is a high degree of confidence that no unwanted cross-pollinations have occurred (12).

In andromonoecious varieties it is necessary to emasculate perfect flowers prior to making desired pollinations. This complicates the mechanical procedure but not prohibitively so in small scale experiments. As a precaution it is advisable to utilize perfect flowers on the day of opening before their anthers have dehisced. Pollination should be done in the afternoon with pollen collected early in the morning (8).

Field: Muskmelons grown in the field are subject to more environmental fluctuation and less control by the experimenter. In greenhouse breeding it is possible to make almost certain that only desired pollinations occur but under field conditions the random activity of insect vectors must be considered (7).

In breeding experiments where the desired female parent is monoecious, it is possible to remove the staminate blossoms from these plants and alternate the planting with rows or hills of the desired male parent. This technique leaves the pollination to insect vectors and if the experimental plot is at least one-half mile from the nearest muskmelon planting, reasonable assurance can be had that the desired crosses are made. If sib-pollination is desired it would not be necessary to remove the staminate

blossoms (7).

For andromonoecious varieties, controlled crosses are more difficult since natural self-pollination can occur. The best technique seems to be to make the desired cross or self or sib pollinations early in the morning, on blossoms which were emasculated the previous night, before insect vectors become active. If there is reasonable assurance that the blossom is recently opened, the same technique used in the greenhouse is advisable (8).

A possible advantage may be gained in breeding work from utilization of a male sterile variety as the seed parent. Such a variety is possible, and in the particular strain found, the male-sterile character was apparently inherited as a simple Mendelian recessive (3).

From available information on melon breeding techniques it seems likely that the best results, for precise breeding experiments, are to be obtained from work conducted in the greenhouse. This is due to the precise control of environment and insect populations possible only in an enclosed space (9).

### Determination of Quality in Muskmelons

#### External Morphology

The external factors determining quality in the muskmelon, Cucumis melo, vary with the type or botanical variety considered.

Fruit shape: This factor cannot be exactly defined since regional consumer preferences determine which fruits have the most desirable form. In general, fruits of spherical, oblate, or ellipsoid shapes are most



acceptable. This is probably due largely to two considerations, namely, 1) most muskmelons grown commercially fall into one of these categories, and 2) regularly shaped fruits lend themselves more easily to packing for shipment and display for sale to the consumer.

For experimental purposes, a convenient method of indicating approximate fruit shape is to express it as a ratio of the equatorial diameter to the polar diameter, e.g., 0.675, 0.775, 1.000, etc. The accuracy of this method depends entirely on the regularity of shape of the fruits measured (5).

Fruit size and weight: Standards for size and weight are determined largely by consumer preference and the use to which the melon will be put. In general, a fruit weighing from two to six pounds and of such size as to furnish two or more adequate servings is most desirable.

Currence, et. al., reported on, in 1944, the development of a simple alignment chart for making rapid determinations of muskmelons' volumes and densities. The technique consists of measuring the equatorial and polar diameters of the fruit, picking these off two scales on the alignment chart and reading the approximate volume directly. The density can then be computed by dividing the weight of the fruit by the volume determined from the alignment chart (5).

#### Internal Morphology

There is a very wide variation in acceptable flesh colors in muskmelons. The normal range covers white, several shades of green, and from pale yellow-orange through deep salmon. The texture of a quality

melon is difficult to define, but in general should be crisp and moist. Undesirable melons might have dry, very soft or stringy flesh.

Usually the thickness of the flesh is indicated by the size of the seed cavity in relation to the size of the melon. The extent of the seed cavity may be indicated by using the density determined from the alignment charts aforementioned (5). The ideal condition is a very small seed cavity and very thick flesh.

#### Nutritional Value

Wagner, et. al., in 1939, reported that in tests conducted with sixteen varieties of muskmelon, a correlation of  $0.894 \pm 0.034$  was found between the refractive index and the vitamin C content of the fruits. This is sufficiently valid to allow for acceptable estimation of vitamin C content under field conditions. In practice, however, very little attention has been paid to data of vitamin content of melons, but it is conceivable that this factor will receive more attention in future work (11).

The single group of internal constituents which receive most attention in melon breeding or quality control work is the group called collectively the "soluble solids". In muskmelons this term practically is synonymous with sugars. In the list below are the findings of G. W. Scott regarding the variation in soluble solids within individual fruits:

1. The soluble solids content is lowest at the stem end and higher toward the apical end of the fruit.
2. The variation between the highest and the lowest reading may be as much as four per cent.

3. With some exceptions there is a gradual increase in readings made along a horizontal plane from stem to apical end.
4. Readings around the equatorial circumference may vary up to one per cent but show no consistent variations.
5. No consistent differences between the lower or ground half and the upper half of the melons seem to exist.
6. The soluble solids content of the juice of the placenta or that found in the seed cavity is usually between the extremes of that found in the flesh, but higher than the composite sample of juice.
7. The soluble solids content of that portion of the flesh nearer the seed cavity is higher than that of the flesh nearer the rind.
8. To determine with reasonable accuracy the soluble solids content of a melon it seems necessary to use the juice expressed from all the edible flesh of a longitudinal segment of the fruit, or preferably, from the entire fruit.
9. The use of the Zeiss hand refractometer is a convenient, rapid and accurate means of determining the percent of soluble solids in the flesh of the cantaloup.
10. Determinations made by the refractometer agree closely with those made by means of the Brix hydrometer (10).

#### Instruments Used in Determining Quality

The only instruments normally used in quality determination in

muskmelons are those which provide information on percentages of soluble solids in the expressed juice. The most commonly used device is the hand refractometer, which gives readings directly in percent of soluble solids in the sample of juice tested.

In 1941, Allinger, Bisson, et. al., conducted experiments to determine the reliability of soluble solids determination with the hand refractometer as opposed to two more exact and slower methods (1).

Table 1 indicates the results obtained when three test solutions were used, i.e.,  $K_2HPO_4$  in water; sucrose in water;  $K_2HPO_4$  plus sucrose in water. All three solutions were tested by all three methods, namely: drying and weighing solids; using the hand or field refractometer and using the Abbe' refractometer, then converting the readings to sucrose using Schonrock's tables (1).

TABLE 1. Comparison of Solids by Drying, Field Refractometer, and Abbe' Refractometer on Organic and Inorganic Substances.

| Substance<br>in Water    | Per cent Solids |                        |   |
|--------------------------|-----------------|------------------------|---|
|                          | By Weight       | Field<br>Refractometer | Abbe' reading converted<br>to sucrose by Schonrock's<br>table |
| $K_2HPO_4$               | 0.53            | 0.4                    | 0.5   |
| Sucrose                  | 10.0            | 9.9                    | 10.0  |
| $K_2HPO_4$ )<br>Sucrose) | 10.0<br>0.53    | 10.4                   | 10.5  |

Similar results were obtained with potassium sulfate, dextrose, sucrose with potassium sulfate.

Tests using melon juice gave results comparable to those obtained

with the test solutions indicated in Table 1 (1).

Prior to the experiments of Allinger, Bisson, et. al., reported above, Currence and Larson had reported that the accuracy of a single testing with the hand refractometer has a standard error of estimate approximately equal to the standard error of the mean of six or eight testing estimates (for sweetness) (4).

### Previous Experiments Conducted in Developing

#### Powdery Mildew Resistant Muskmelons

The earliest recorded experiments in the United States stemmed from the virulent attack of the powdery mildew fungus in the Imperial Valley of California in 1925. For the years 1925, 1926, 1927 and 1928 the cantaloup industry appeared to be doomed in that section of the country. The attacking fungus, Erysiphe cichoracearum, could not be controlled by the fungicides available at the time (13).

J. T. Rosa of the California Agricultural Experiment Station and I. C. Jagger of the United States Department of Agriculture began to search for naturally occurring resistance to the powdery mildew fungus. In the years 1926, 1927 and 1928 they grew melons from all parts of the world, exposed the plants to the fungus disease, and when resistance was found attempted to incorporate it into a commercially acceptable variety (13).

The actual technique used in testing for resistance was as follows:

1. Six inch pots in the greenhouse are planted with four to six seeds per pot.

2. When the first true leaves have unfolded, the plants are placed in a shaded glass-sash chamber.
3. Conidia from heavily infected leaves are then blown over the plants.
4. Between 18 and 24 hours later, the plants are removed from the chamber.
5. Within 16 days after inoculation, readings on the degree of powdery mildew resistance are made (9).

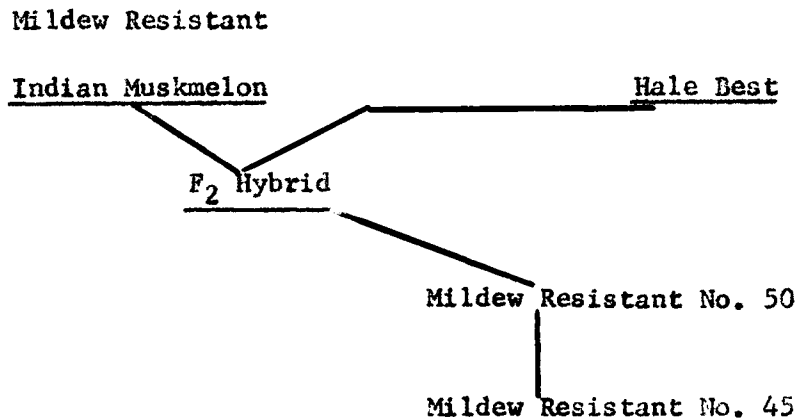
In the year 1928, as Jagger and Scott report,

"numerous plants in several mixed varieties from India remained entirely free from mildew throughout the season, whereas other plants of the same varieties and all plants of many other varieties were badly mildewed. Unfortunately the fruits on all mildew-free plants were commercially useless because of poor shipping and eating qualities. Crosses were then made with several leading American varieties. Mildew resistance was found to be inherited as a simple Mendelian dominant factor. This made feasible backcrossing the hybrids with American varieties, which procedure has apparently hastened the development of strains combining the mildew resistance of the Indian varieties and the desirable shipping and eating qualities of the American varieties." (6).

Subsequent to the discovery of naturally occurring resistance to powdery mildew, by a series of crosses and backcrosses, Powdery Mildew Resistant Cantaloup No. 50 was introduced in 1932. The fruits were quite

variable in size, shape and quality. It was produced from a cross between the Hale Best variety and one of the resistant plants in the Indian varieties. Individuals from the  $F_2$ , or second hybrid generation, were backcrossed to Hale Best and this was followed by two additional generations of selection (13).

After P. M. R. Cantaloup No. 50 was introduced, four more generations of selection finally gave Powdery Mildew Resistant Cantaloup No. 45, grown commercially for the first time in 1936. No. 45 is quite uniform in size, shape and quality and has superior shipping qualities. A partial pedigree of the two mildew resistant melons discussed above is as follows:



(From U.S.D.A. Yearbook, 1937, pp. 217) (13).

In 1938 a new race of Erysiphe cichoracearum appeared, to which all commercial cantaloups, including P. M. R. No. 45, were very susceptible.

The appearance of a second race or biotype of mildew on cantaloups required an alteration in breeding and testing techniques, and more complete information regarding the biology of the parasite appeared to be essential.

As Pryor et. al. say,

"The fungus Erysiphe cichoracearum is composed of many biotypes which attack a large number of host species in a great many families. Undoubtedly there are overlappings in the host ranges of many of these races. Furthermore, since the sexual stage occurs occasionally in some of them, variation may result from natural hybridization. It was therefore not surprising when a new race of the fungus appeared shortly after Powdery Mildew Resistant Cantaloup No. 45 was introduced. Likewise, other troublesome races or variants may be expected to appear in the future." (9).

The search for resistance to race 2 of the powdery mildew fungus was restricted to the Cucumis melo species since previous experiments had indicated that no other species offered any greater source of resistance. In addition it has been found very difficult or impossible to cross C. melo with other species of Cucurbitaceae (9).

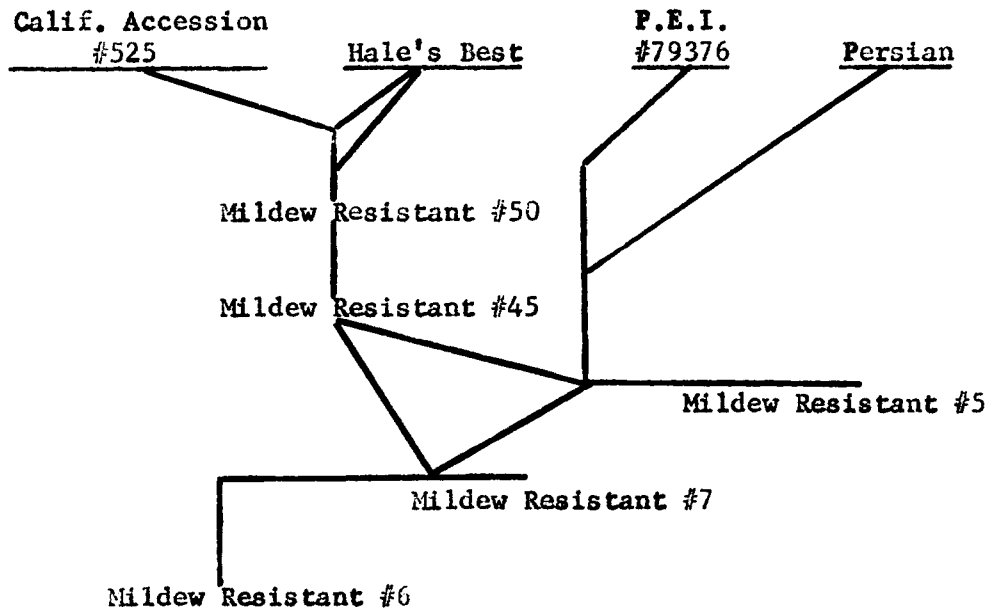
Plant introduction materials used were screened for resistance and those showing little or no resistance to the fungus disease were dis-



carded immediately. The other plants were utilized as described by Pryor, et. al.:

"The procedure has been to identify and isolate for selfing, plants showing the greatest ability to withstand mildew attacks, and by this method eventually to obtain through inbreeding and selection individuals that are homozygous for resistance. In conjunction with this plan, a series of crosses and backcrosses between commercial types and the most resistant material is initiated. The progeny from each cross or self is tested in the greenhouse for disease resistance, and the most resistant individuals are given a field trial to determine their fruit and vine characteristics, as well as to obtain their mildew reaction under field conditions. When a strain approaches the desired level of mildew resistance, a large planting is made for increase and for rigorous selection of desirable fruit and vine types under commercial conditions. By employing spring crops in the Imperial Valley, and summer crops at Davis and Torrey Pines, two generations can be grown each year."

"As a result of this program Powdery Mildew Resistant Cantaloup No. 5 was released to seedsmen and growers in 1942, and No. 6 and No. 7 in 1944. These strains possess a much higher level of resistance to race 2 than does No. 45, although they cannot be considered as immune from powdery mildew. Their genetic relationship is shown below."



(from Pryor, Whitaker, and Davis, 1946.) (9).

Powdery Mildew Resistant Cantaloup No. 5 makes a heavy vine growth with dark green leaves. The melon has a large stem scar and a fine, low net which does not entirely cover sutures. The high quality of the fruit is reflected in refractometer readings of 13 to 14 per cent soluble solids. It is not as early as some other varieties and it is not completely resistant to mildew.

Powdery Mildew Resistant Cantaloups No. 6 and No. 7 are similar in their pedigree to No. 5 except that they have been backcrossed to No. 45 one more time. They are also similar in vine characteristics, but No. 6 and No. 7 have slightly different fruit characters. No. 6 has a small button-like protrusion at the blossom end of the fruit. It is well netted, well shaped, and of very attractive appearance. However it has a larger seed cavity than No. 5 and the flesh has less quality and flavor.

No. 7 produces a small, oblate melon and in comparison with No. 5 and No. 6 is somewhat later in maturity. The seed cavity and flesh are comparable to No. 6 (9).

Since this last paper quoted was published, several muskmelons with some degree of resistance to powdery mildew have been introduced. A few of these are: Powdery Mildew Resistant Cantaloup No. 8 from the United States Department of Agriculture field station at La Jolla, California; Georgia 52, introduced by the Georgia Agricultural Experiment Station; and Homegarden introduced by Mississippi Agricultural Experiment Station.

There have been, however, no nationally distributed technical papers published on the development of any of these melons or on any work with resistance to powdery mildew in melons since 1946.

## EXPERIMENTAL PROCEDURES

### Varieties or Breeding Lines

Throughout this paper a numerical code is used for identifying the specific breeding lines of Cucumis melo utilized. This code is uniform throughout the experiment and is as follows:

| <u>Code</u> | <u>Definition</u>  |
|-------------|--|
| 16          | Ambrosia -- the only named variety employed. Selected from a series of random crosses by Louis Promos of Leesburg, Virginia. |
| PI-2        | U.S.D.A. Plant Introduction selection number 179913 from India.  |
| PI-3        | U.S.D.A. Plant Introduction selection number 182953 from India.  |
| PI-4        | U.S.D.A. Plant Introduction selection number 182959 from India.  |

### Planting of Seed and Spacing of Plants

Seeds used in the experiment were started in flats containing a sterilized soil mixture composed of one-third peat moss, one-third sand and one-third top soil. The seeds were planted 35 or 40 to a flat in individual Bird Vita-bands, 2½ x 2½ inches in size.

When the plants had produced several true leaves (two to five weeks after seeding), they were set out in the greenhouse or field. The spacings were as follows:

| <u>Location</u>        | <u>Spacing Used</u>  |
|------------------------|--|
| greenhouse benches     | 4' between plants (single row in each bench).  |
| greenhouse ground beds | 4' between plants in row<br>4' between rows with plants staggered in adjacent rows.        |
| field                  | 4' between plants in row.<br>4' between rows, with plants directly adjacent to each other. |

#### Inoculation of Plants with the Powdery Mildew Fungus

Several techniques were tried in the inoculation of young muskmelon plants with the powdery mildew fungus, Erysiphe cichoracearum.

One procedure used was to erect a framework about three feet high over a bench in the greenhouse. This structure was then covered completely with a sheet of polyethylene film. The plants to be inoculated were placed under this covering on the bench and several mature Ambrosia plants badly infected with powdery mildew were placed on the bench at one end. A small household type electric fan was installed on the bench behind the mature plants (i.e. on the side away from the seedlings). This fan was allowed to run and disseminate spores from the infected plants toward the seedlings.

This procedure has merit in that the spread of pathogenic organisms from the infected plants is largely limited to the area under the plastic cover. In practice this was found to be a relatively time consuming method of achieving inoculation on exposed plants.

Another technique that was used is considered to be the most effec-

tive and thorough method for inoculation with powdery mildew. This method involved harvesting heavily infected leaves from mature plants and manually applying the disease spores to each seedling being tested by blotting the seedling leaves on top and undersides with the infected leaves from mature plants.

Several observations can be made on inoculation in general:

1. No infection was observed on cotyledons or seed leaves of any plant before the time when the plant had produced true leaves, except Ambrosia.
2. At temperatures of 90°F. or above little or no infection occurred on previously uninfected plants.
3. The rapid growth of muskmelon plants under favorable conditions makes it very difficult to evaluate quantitative differences in degree of infection before it becomes necessary to transplant the seedlings from flats to field or greenhouse plots. If the plants become too large in the flats they are very susceptible to becoming rootbound and/or to breakage of the succulent stems on transplanting.

#### Breeding Techniques

All of the breeding work done in these experiments was conducted in glass or plastic greenhouses.

One standard procedure was followed throughout. Munger (1942) had found that better sets of fruit could be obtained if pollinations were followed by a relatively cool period. This suggests making pollinations in the late afternoon, before anthesis and immediately after

emasculatation.

This procedure was followed but the pollen used was collected early in the morning of the day pollinations were to be made. This technique, utilized due to the much reduced viability of the pollen after noon, consisted of collecting staminate flowers and placing them in petri dishes containing moist filter paper. The petri dishes were then put in a cool place until later in the day when pollinations were made.

The actual procedure used was as follows:

1. Corolla and anthers removed from perfect flowers with forceps sterilized in 95% ethanol.
2. Corolla stripped from the previously collected staminate flowers and the anthers applied lightly to the exposed stigmas of the perfect flowers.
3. One-half of a small gelatin capsule, containing a small piece of sterile absorbent cotton in the end, placed over the pollinated stigmas.
4. A small cardboard tag containing the date and the strains involved in the cross was placed around the stem of the perfect flower. For these experiments, red tags were used for self and sib pollinations and yellow tags were used for cross and backcross pollinations.

#### Harvesting and Sampling Procedure

The marked variation found in mature melons used in these experiments made it difficult to determine the proper time for harvest.

Muskmelons which slipped their stems at maturity were harvested without difficulty but most of the strains utilized did not exhibit the slip characteristic. In the latter type, maturity had to be determined by the investigator on the basis of skin color, fruit size, aroma and general appearance of the individual melons.

In the greenhouse experiments a representative sample of mature fruit was taken from each strain of muskmelons raised.

In the field experiments at Warsaw and Blacksburg, Virginia, the experimenter attempted to harvest three or four mature fruit, free of insect and/or mechanical injury, from each row of each strain grown.

After harvest the sample melons were placed overnight in storage rooms at 55°F. This was done to eliminate temperature of the fruit as a factor in rating them subjectively. Upon removal from storage the melons were subjected to the following procedure:

1. Weighed in pounds and ounces.
2. Slided open on the stem to blossom end axis.
3. Dimensions, internal and external on both axes, recorded in inches.
4. Flesh firmness tested near both ends and at the middle with a seven-sixteenths punch on a standard Magness-Taylor pressure tester. The mean pressure of the three pressures taken was recorded.
5. Small (teaspoon size) flesh samples from each fruit were tested organoleptically by the experimenter.



6. Soluble solids were determined in the expressed juice with a Bausch and Lomb hand refractometer.
7. Skin color, flesh color and fruit shape were observed and recorded.

VI

PRESENTATION OF RESULTS

Genetic Information

Throughout these experiments, every Ambrosia melon plant grown to maturity in greenhouses proved to be very susceptible to infection with the powdery mildew fungus.

The Ambrosia plants used for breeding work were kept reasonably free of powdery mildew by periodic applications of Karathane WC as a water suspension spray.

Winter 1956-1957

F<sub>1</sub> plants were grown in the greenhouses at Virginia Polytechnic Institute in the manner previously described. Two plants each of the following types were grown to maturity: 16 X PI<sub>2</sub>, 16 X PI<sub>3</sub> and 16 X PI<sub>4</sub>.

In addition to these, four Ambrosia plants were grown in the same greenhouse.

At the suitable time, numerous pollinations were made and the following fruits were procured:

| <u>Cross</u>                 | <u>Number of Fruit</u> |
|------------------------------|------------------------|
| 16 X PI <sub>2</sub> X Self  | 1                      |
| 16 X PI <sub>3</sub> X Self  | 1                      |
| 16 X PI <sub>4</sub> X Self  | 2                      |
| (16 X PI <sub>2</sub> ) X 16 | 1                      |

| <u>Cross</u>                 | <u>Number of Fruit</u> |
|------------------------------|------------------------|
| (16 X PI <sub>3</sub> ) X 16 | 1                      |
| 16 X (16 X PI <sub>4</sub> ) | 1                      |

In each of these fruits the pistillate parent is listed to the left, i.e. first, and the staminate parent to the right.

In March, when the F<sub>1</sub> plants were four months old, the following observations were made on susceptibility to powdery mildew:

| <u>Cross</u>         | <u>Number of Plants</u> | <u>Number Susceptible</u> |
|----------------------|-------------------------|---------------------------|
| 16 X PI <sub>2</sub> | 2                       | 2                         |
| 16 X PI <sub>3</sub> | 2                       | none                      |
| 16 X PI <sub>4</sub> | 2                       | none                      |
| Ambrosia             | 4                       | 4                         |

Spring and Summer 1957

In May the following numbers of seeds were planted in flats. These were all of the seeds available from the F<sub>1</sub> plants.

| <u>Cross</u>                 | <u>Number Seeds Planted</u> |
|------------------------------|-----------------------------|
| 16 X PI <sub>2</sub> X Self  | 199                         |
| 16 X PI <sub>3</sub> X Self  | 86                          |
| 16 X PI <sub>4</sub> X Self  | 455                         |
| (16 X PI <sub>2</sub> ) X 16 | 385                         |
| (16 X PI <sub>3</sub> ) X 16 | 105                         |
| 16 X (16 X PI <sub>4</sub> ) | 245                         |
| Ambrosia                     | 140                         |

When the small plants from this seeding had produced their first true leaves, all of them, except the Ambrosia plants, were carefully inoculated with spores of the powdery mildew fungus.

On June 10, 1957, when the plants were three weeks old, the following were transported to Warsaw, Virginia and planted in the field

| <u>Cross</u>                 | <u>Number Planted</u> |
|------------------------------|-----------------------|
| 16 X PI <sub>2</sub> X Self  | 45                    |
| 16 X PI <sub>3</sub> X Self  | 15                    |
| 16 X PI <sub>4</sub> X Self  | 45                    |
| (16 X PI <sub>2</sub> ) X 16 | 45                    |
| (16 X PI <sub>3</sub> ) X 16 | 45                    |
| 16 X (16 X PI <sub>4</sub> ) | 45                    |

At the time these plants were set out in the field, there was no evidence of powdery mildew on any of them.

On June 20, 1957 the following information was recorded on the plants remaining at Blacksburg.

| <u>Cross</u>                 | <u>Number of Plants</u> | <u>Number Infected</u><br><u>With Powdery Mildew</u> | <u>Per cent Infection</u> |
|------------------------------|-------------------------|--|---------------------------|
| 16 X PI <sub>2</sub> X Self  | 83                      | 65   | 78.3                      |
| 16 X PI <sub>3</sub> X Self  | 35                      | none   | 0.0                       |
| 16 X PI <sub>4</sub> X Self  | 226                     | 111  | 49.1                      |
| (16 X PI <sub>2</sub> ) X 16 | 287                     | 249  | 86.8                      |
| (16 X PI <sub>3</sub> ) X 16 | 31                      | 16   | 51.6                      |
| 16 X (16 X PI <sub>4</sub> ) | 150                     | 106  | 70.7                      |
| Ambrosia                     | 70                      | not inoculated                                       |                           |

The uninfected plants were planted out in the field and in greenhouses at Blacksburg, Virginia.

On June 25, 1957, it was learned that the melon plants at Warsaw were being treated inadvertently, with a fungicidal preparation, copper rotenone. The spray was immediately discontinued and there was no evidence of powdery mildew on these plants. The entire planting at Warsaw remained free of powdery mildew throughout the growing season.

#### Quality Information

Production of a high quality melon was not a stated objective of this study. However, this melon is a potentially important economic crop and therefore quality is an important consideration. The data taken on weight, size, shape, flesh firmness and taste, soluble solids in expressed juice and general appearance are tabulated in the appendix.

In addition, the results of a preliminary storage experiment appear in the appendix also. The melons used in this experiment were furnished by Mr. Promos from his commercial planting.

VII

DISCUSSION OF RESULTS

Presumably the strains of muskmelons from the Plant Exploration and Introduction Service are homozygous since the lines are maintained by continuous inbreeding.

The Ambrosia melon is apparently homozygous for susceptibility to the powdery mildew fungus, since every plant of this variety grown at V.P.I. has become infected if exposed to the disease.

This being the case, it seems that any  $F_1$  fruit from a cross between a given plant introduction selection and the Ambrosia melon will have essentially the same genotype for any given characteristic as any other fruit with the same parentage.

$F_1$  Melons

The six  $F_1$  melon plants grown in the greenhouse for breeding purposes give a reasonably accurate representation of any  $F_1$  melon plant of the same parentage. Therefore, from the observations made, it seems that resistance to powdery mildew has at least some degree of dominance in  $PI_3$  and  $PI_4$  but not necessarily in  $PI_2$ .

$F_2$  Melons

When the  $F_1$  plants were self pollinated or backcrossed to the Ambrosia plants, only a limited number of fruit were set. Those few fruit, however, should be reasonably representative of  $F_2$  or  $B_1$  (i.e. first gene-

ration backcross) progeny.

It is unfortunate that the plants set out at Warsaw were prevented from demonstrating susceptibility. It is still possible to make several deductions even though it is not possible to use a Chi square test on the partial data available.

On the basis of the data taken at Blacksburg, the following statements can be made:

1. All three of the plant introduction selections used possess a greater degree of resistance than does the Ambrosia melon.
2. PI<sub>3</sub> shows the most promise as a source of commercial resistance.
3. The general technique used in developing the commercial powdery mildew resistant cantaloupes can be applied to the Ambrosia with reasonable hope of success.

VIII

SUMMARY

An experiment was instituted to incorporate resistance to the powdery mildew fungus Erysiphe cichoracearum DC into the Ambrosia muskmelon, a melon of the Casaba or winter type.

First generation hybrid ( $F_1$ ), first generation backcross ( $B_1$ ) and second generation inbred ( $F_2$ ) plants were grown to maturity at Blacksburg and Warsaw, Virginia.

On the basis of the data obtained the following conclusions are drawn:

1. The muskmelon material acquired from the Plant Exploration and Introduction Service is a good source of powdery mildew resistance and of the material tested,  $PI_3$  showed the most promise as a source of commercial resistance.

2. The general technique of hybridizing a susceptible with a resistant plant can be used to advantage in incorporating disease resistance into the Ambrosia melon.

3. Further work is needed to obtain a commercially acceptable Ambrosia melon which is essentially homozygous for resistance to powdery mildew, and to determine the exact mechanism of inheritance of powdery mildew resistance.



IX

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**XIII**  
**APPENDIX**

Figure 1. Exterior and interior views of  
Ambrosia melon. Background is  
marked off in one inch squares.





Figure 1.

Figure 2. The Ambrosia melons used in the 1957 storage experiment. The results of this experiment are tabulated on the following page.



Figure 2.

1957 MUSKMELON STORAGE EXPERIMENT

Harvested 9-11 or 9-12/57 - Louis Promos

Three Temps x Four Periods x Two Reps = 24  
 40°, 55°, 70°      1, 2, 3, 8 wks.

|                       | <u>Original Weight</u> |     | <u>Final Weight</u> |     | <u>Soluble Solids</u> | <u>Firmness</u> | <u>Flavor</u>     |
|-----------------------|------------------------|-----|---------------------|-----|-----------------------|-----------------|-------------------|
|                       | Lbs.                   | Oz. | Lbs.                | Oz. | %                     | Lbs.            |                   |
| 9/20/57 (One Week)    |                        |     |                     |     |                       |                 |                   |
| I - 1 - 4             | 4                      | 12  | 4                   | 10  | 10.0                  | 2.0             | Excellent         |
| II - 1 - 4            | 4                      | 14  | 4                   | 12  | 14.0                  | 1.5             | Fair              |
| I - 1 - 5             | 6                      | 7   | 6                   | 6   | 14.0                  | 1.5             | Fair              |
| II - 1 - 5            | 4                      | 2   | 4                   | 1   | 12.0                  | 1.0             | Good              |
| I - 1 - 7             | 4                      | 9   | 4                   | 7   | 13.0                  | 0.5             | Poor              |
| II - 1 - 7            | 6                      | 5   | 6                   | 3   | 13.0                  | 0.5             | Fair              |
| 9/27/57 (Two Weeks)   |                        |     |                     |     |                       |                 |                   |
| I - 2 - 4             | 4                      | 9   | 4                   | 7   | 14.5                  | 2.5             | Good              |
| II - 2 - 4            | 3                      | 13  | 3                   | 11  | 14.5                  | 2.5             | Good              |
| I - 2 - 5             | 5                      | 10  | 5                   | 7   | 16.5                  | 0.5             | Good (very sweet) |
| II - 2 - 5            | 5                      | 7   | 5                   | 4   | 15.0                  | 0.5             | Good              |
| I - 2 - 7             | 4                      | 8   | 4                   | 5   | 11.5                  | 0.5             | Poor              |
| II - 2 - 7            | 4                      | 5   | 4                   | 2   | 16.0                  | 0.5             | Poor (fermented)  |
| 10/5/57 (Three Weeks) |                        |     |                     |     |                       |                 |                   |
| I - 3 - 4             | 4                      | 6   | 4                   | 4   | 12.5                  | 2.5             | Good              |
| II - 3 - 4            | 4                      | 8   | 4                   | 2   | 14.0                  | 3.5             | Good              |
| I - 3 - 5             | 4                      | 13  | 4                   | 10  | ----                  | ---             | <u>Rotten</u>     |
| II - 3 - 5            | 5                      | 12  | 5                   | 10  | 14.5                  | 0.5             | Very sweet        |
| I - 3 - 7             | 4                      | 10  | 4                   | 7   | 13.0                  | 0.5             | Fair              |
| II - 3 - 7            | 6                      | 2   | 5                   | 12  | ----                  | ---             | <u>Rotten</u>     |
| 11/8/57 (Eight Weeks) |                        |     |                     |     |                       |                 |                   |
| I - 4 - 4             | 6                      | 10  | 5                   | 14  | 10.5                  | 1.0             | Fair              |
| II - 4 - 4            | 4                      | 1   | 3                   | 8   | 12.0                  | 2.0             | Good              |
| I - 4 - 5             | 5                      | 1   | 4                   | 11  | ----                  | ---             | <u>Rotten</u>     |
| II - 4 - 5            | 5                      | 12  | 5                   | 4   | 9.0                   | 0.0             | Good              |
| I - 4 - 7             | 5                      | 7   | 4                   | 15  | 12.0                  | 0.0             | Poor              |
| II - 4 - 7            | 3                      | 15  | 3                   | 9   | 12.0                  | 0.0             | Fair              |

Note: 9/27/57 -- Melons in 70° temperature storage beginning to break down. Rinds getting soft and anthracnose lesions starting.

SIZE AND QUALITY OBSERVATIONS

AMBROSIA MELON

WARSAW, VA. 8-20-57

| <u>Row No.</u> | <u>Weight</u><br>(Ounces) | <u>Dimensions</u> |           | Shape | <u>Fruit</u> |       |
|----------------|---------------------------|-------------------|-----------|-------|--------------|-------|
|                |                           | Outer<br>(Inches) | Inner     |       | Texture      | Color |
| 21             | 42                        | 6.5 x 4.7         | 4.7 x 2.5 | Ov    | Fd           | Y     |
| 21             | 38                        | 6.5 x 4.5         | 4.5 x 2.2 | Ov    | Fd           | Y     |
| 21             | 53                        | 7.0 x 4.8         | 5.0 x 2.5 | Oblg  | Fd           | Y     |
| 1              | 34                        | 6.7 x 4.2         | 4.7 x 2.5 | Oblg  | Fd           | Y     |
| 1              | 58                        | 8.2 x 5.0         | 5.5 x 2.5 | Oblg  | Fd           | Y     |
| 1              | 47                        | 6.7 x 5.1         | 4.7 x 2.5 | Oblg  | Fd           | Y     |
| 1              | 50                        | 7.1 x 4.8         | 5.0 x 2.5 | Oblg  | Fd           | Y     |
| 11             | 48                        | 7.5 x 4.7         | 5.2 x 2.2 | Oblg  | Fd           | Y     |
| 11             | 33                        | 6.5 x 4.0         | 4.5 x 2.5 | Oblg  | Fd           | Y     |
| 11             | 43                        | 7.0 x 4.6         | 4.2 x 2.3 | Oblg  | Fd           | Y     |
| 11             | 59                        | 7.5 x 5.0         | 5.1 x 2.5 | Oblg  | Fd           | Y     |

| <u>Row No.</u> | <u>Firmness</u><br>(Lbs.) | <u>Soluble Solids</u><br>(%) | Taste | <u>Flesh</u> |  | Color |
|----------------|---------------------------|------------------------------|-------|--------------|--|-------|
|                |                           |                              |       | Aroma        |  |       |
| 21             | 3.0                       | 7.5                          | I     | None         |  | LG    |
| 21             | 3.0                       | 7.0                          | I     | None         |  | LG    |
| 21             | 3.5                       | 9.0                          | I     | None         |  | LG    |
| 1              | 7.0                       | 5.5                          | I     | None         |  | LG    |
| 1              | 3.5                       | 7.5                          | I     | Sweet        |  | LG    |
| 1              | 4.5                       | 9.0                          | I     | None         |  | lg    |
| 1              | 2.5                       | 10.0                         | I     | None         |  | LG    |
| 11             | 6.0                       | 4.5                          | I     | Sweet        |  | LG    |
| 11             | 3.5                       | 3.5                          | I     | None         |  | LG    |
| 11             | 2.0                       | 7.0                          | I     | None         |  | LG    |
| 11             | 4.0                       | 10.5                         | I     | None         |  | LG    |

## SIZE AND QUALITY OBSERVATIONS

AMBROSIA MELON

BLACKSBURG, VA. 9-21-57

| Row No. | Weight<br>(Ounces) | Dimensions<br>(Inches) |           | Shape | Fruit   |       |
|---------|--------------------|------------------------|-----------|-------|---------|-------|
|         |                    | Outer                  | Inner     |       | Texture | Color |
| 3       | 77                 | 8.2 x 5.5              | 5.5 x 3.0 | Oblg  | Fd      | Y     |
| 3       | 58                 | 7.0 x 5.2              | 5.0 x 2.7 | Oblg  | Fd      | Y     |
| 3       | 42                 | 7.0 x 4.7              | 4.5 x 2.5 | Oblg  | Sm      | Y     |
| 9       | 37                 | 6.7 x 4.5              | 4.7 x 2.0 | Ov    | Sm      | Y     |
| 9       | 121                | 10.0 x 6.2             | 7.2 x 3.5 | Oblg  | Fd      | Y     |
| 9       | 48                 | 7.5 x 4.5              | 5.5 x 2.2 | Oblg  | Fd      | Y     |
| 13      | 66                 | 8.7 x 5.0              | 6.5 x 2.5 | Oblg  | Fd      | Y     |
| 13      | 62                 | 8.5 x 5.0              | 6.5 x 2.7 | Oblg  | Fd      | Y     |
| 14      | 56                 | 7.0 x 5.2              | 5.0 x 3.0 | Oblg  | Fd      | Y     |
| 14      | 56                 | 8.2 x 4.7              | 5.7 x 2.7 | Elg   | Fd      | Y     |
| 14      | 55                 | 8.0 x 4.7              | 5.7 x 2.7 | Elg   | Sm      | Y     |
| 15      | 56                 | 7.5 x 5.0              | 5.5 x 2.5 | Oblg  | Fd      | Y     |
| 15      | 63                 | 7.7 x 5.0              | 6.0 x 2.7 | Oblg  | Fd      | Y     |
| 15      | 58                 | 8.0 x 5.0              | 5.7 x 2.5 | Elg   | Fd      | Y     |

| Row No. | Firmness<br>(Lbs.) | Soluble Solids<br>(%) | Taste | Flesh |       |
|---------|--------------------|-----------------------|-------|-------|-------|
|         |                    |                       |       | Aroma | Color |
| 3       | 2.5                | 10.0                  | I     | Sweet | LG    |
| 3       | 3.0                | 9.0                   | I     | Sweet | LG    |
| 3       | 3.0                | 8.0                   | I     | None  | LG    |
| 9       | 4.5                | 8.0                   | I     | Sweet | LG    |
| 9       | 3.0                | 7.0                   | I     | None  | LG    |
| 9       | 3.0                | 6.0                   | I     | None  | LG    |
| 13      | 3.0                | 7.5                   | I     | Sweet | LG    |
| 13      | 4.0                | 7.0                   | I     | Sweet | LG    |
| 14      | 2.5                | 6.0                   | I     | None  | LG    |
| 14      | 2.5                | 4.5                   | I     | Sweet | LG    |
| 14      | 6.0                | 3.5                   | I     | None  | LG    |
| 15      | 3.5                | 8.0                   | I     | None  | LG    |
| 15      | 4.0                | 8.0                   | I     | None  | LG    |
| 15      | 4.0                | 6.5                   | I     | Sweet | LG    |

SIZE AND QUALITY OBSERVATIONS

16 x PI<sub>2</sub> x Self

WARSAW, VA. 8-20-57

| <u>Row No.</u> | <u>Weight</u><br>(Ounces) | <u>Dimensions</u> |           | Shape | <u>Fruit</u> |       |
|----------------|---------------------------|-------------------|-----------|-------|--------------|-------|
|                |                           | Outer             | Inner     |       | Texture      | Color |
| 2              | 66                        | 10.2 x 4.7        | 7.0 x 2.2 | Oblg  | Fd & Nd      | Y     |
| 2              | 37                        | 6.0 x 4.8         | 3.7 x 2.7 | Ov    | Sm           | Y     |
| 2              | 24                        | 5.0 x 4.2         | 3.2 x 2.3 | Ov    | Sm           | Y     |
| 2              | 65                        | 9.2 x 5.6         | 7.0 x 3.2 | Elg   | Sm           | Y     |

| <u>Row No.</u> | <u>Firmness</u><br>(Lbs.) | <u>Soluble Solids</u><br>(%) | Taste | <u>Flesh</u> |       |
|----------------|---------------------------|------------------------------|-------|--------------|-------|
|                |                           |                              |       | Aroma        | Color |
| 2              | 2.5                       | 7.5                          | I     | None         | LG    |
| 2              | 1.5                       | 10.5                         | Sw    | Acid         | LG    |
| 2              | 3.5                       | 11.0                         | A     | Acid         | LG    |
| 2              | 1.5                       | 8.5                          | I     | Acid         | LG    |

16 x PI<sub>3</sub> x Self

| <u>Row No.</u> | <u>Weight</u><br>(Ounces) | <u>Dimensions</u> |           | Shape | <u>Fruit</u> |       |
|----------------|---------------------------|-------------------|-----------|-------|--------------|-------|
|                |                           | Outer             | Inner     |       | Texture      | Color |
| 7              | 36                        | 7.1 x 4.1         | 5.0 x 2.0 | Oblg  | Fd           | YG    |
| 7              | 45                        | 7.2 x 5.0         | 4.7 x 2.8 | Ov    | Fd           | Y     |
| 7              | 43                        | 8.5 x 4.5         | 6.2 x 2.5 | Oblg  | Nd           | YG    |

| <u>Row No.</u> | <u>Firmness</u><br>(Lbs.) | <u>Soluble Solids</u><br>(%) | Taste | <u>Flesh</u> |       |
|----------------|---------------------------|------------------------------|-------|--------------|-------|
|                |                           |                              |       | Aroma        | Color |
| 7              | 1.5                       | 7.5                          | A     | None         | LG    |
| 7              | 6.0                       | 7.5                          | A     | None         | LG    |
| 7              | 4.5                       | 7.0                          | A     | Acid         | LG    |

SIZE AND QUALITY OBSERVATIONS

16 x PI<sub>4</sub> x Self

WARSAW, VA. 8-20-57

| <u>Row No.</u> | <u>Weight</u><br>(Ounces) | <u>Dimensions</u> |              | <u>Shape</u> | <u>Fruit</u>   |              |
|----------------|---------------------------|-------------------|--------------|--------------|----------------|--------------|
|                |                           | <u>Outer</u>      | <u>Inner</u> |              | <u>Texture</u> | <u>Color</u> |
|                |                           | <u>(Inches)</u>   |              |              |                |              |
| 8              | 33                        | 7.2 x 4.0         | 5.0 x 2.0    | Ov           | Sm             | Y            |
| 8              | 56                        | 7.0 x 5.1         | 4.5 x 2.5    | Ov           | Sm             | Y            |
| 8              | 13                        | 3.7 x 3.3         | 2.7 x 1.7    | Rd           | Nd             | Y            |
| 9              | 20                        | 5.0 x 3.6         | 3.5 x 1.8    | Oblg         | Sm             | Y            |
| 9              | 25                        | 5.1 x 4.1         | 3.5 x 2.1    | Ov           | Sm             | YW           |
| 10             | 24                        | 4.2 x 4.2         | 2.2 x 2.2    | Rd           | Sm             | W            |

| <u>Row No.</u> | <u>Firmness</u><br>(Lbs.) | <u>Soluble Solids</u><br>(%) | <u>Taste</u> | <u>Flesh</u> |              |
|----------------|---------------------------|------------------------------|--------------|--------------|--------------|
|                |                           |                              |              | <u>Aroma</u> | <u>Color</u> |
| 8              | 5.5                       | 4.0                          | B            | Cucumber     | LG           |
| 8              | 5.0                       | 5.5                          | B            | Cucumber     | W            |
| 8              | 3.5                       | 9.5                          | B            | Sweet        | G            |
| 9              | 5.0                       | 6.0                          | B            | Cucumber     | LG           |
| 9              | 3.5                       | 6.0                          | I            | None         | LG           |
| 10             | 9.0                       | 7.5                          | B            | Cucumber     | W            |

16 x PI<sub>4</sub> x Self

BLACKSBURG, VA. 9-21-57

| <u>Row No.</u> | <u>Weight</u><br>(Ounces) | <u>Dimensions</u> |              | <u>Shape</u> | <u>Fruit</u>   |              |
|----------------|---------------------------|-------------------|--------------|--------------|----------------|--------------|
|                |                           | <u>Outer</u>      | <u>Inner</u> |              | <u>Texture</u> | <u>Color</u> |
|                |                           | <u>(Inches)</u>   |              |              |                |              |
| 3              | 133                       | 14.0 x 6.5        | 12.5 x 4.0   | Elg          | Sm             | Y            |
| 6              | 39                        | 6.5 x 4.7         | 4.5 x 3.2    | Oblg         | Sm             | Y            |
| 6              | 69                        | 8.0 x 6.0         | 6.5 x 4.2    | Ov           | Nd             | Y            |
| 6              | 41                        | 7.0 x 5.5         | 6.0 x 3.7    | Oblg         | Sm             | Y            |

| <u>Row No.</u> | <u>Firmness</u><br>(Lbs.) | <u>Soluble Solids</u><br>(%) | <u>Taste</u> | <u>Flesh</u> |              |
|----------------|---------------------------|------------------------------|--------------|--------------|--------------|
|                |                           |                              |              | <u>Aroma</u> | <u>Color</u> |
| 3              | 3                         | 5.0                          | B            | None         | W            |
| 6              | 4                         | 4.5                          | B            | None         | W            |
| 6              | 4                         | 6.5                          | B            | None         | W            |
| 6              | 5                         | 6.0                          | B            | None         | W            |



SIZE AND QUALITY OBSERVATIONS

(16 x PI<sub>2</sub>) x 16

WARSAW, VA. 8-20-57

| Row No. | Weight<br>(Ounces) | <u>Dimensions</u> |                   | Shape | <u>Fruit</u> |       |
|---------|--------------------|-------------------|-------------------|-------|--------------|-------|
|         |                    | Outer<br>(Inches) | Inner<br>(Inches) |       | Texture      | Color |
| 14      | 61                 | 7.7 x 5.0         | 5.7 x 2.5         | Oblg  | Fd           | Y     |
| 14      | 49                 | 7.1 x 4.8         | 5.0 x 2.7         | Oblg  | Fd           | Y     |
| 14      | 37                 | 6.5 x 4.6         | 4.5 x 2.5         | Ov    | Fd           | Y     |
| 14      | 52                 | 7.5 x 4.8         | 5.5 x 2.6         | Oblg  | Fd           | Y     |
| 13      | 53                 | 7.8 x 5.0         | 5.2 x 2.5         | Oblg  | Fd           | Y     |
| 13      | 45                 | 7.5 x 4.8         | 5.2 x 2.2         | Oblg  | Fd           | Y     |
| 13      | 65                 | 6.7 x 5.8         | 4.7 x 3.0         | Ov    | Fd           | Y     |
| 13      | 38                 | 6.5 x 4.2         | 4.7 x 2.2         | Oblg  | Fd           | Y     |
| 12      | 37                 | 6.6 x 4.1         | 4.7 x 2.2         | Oblg  | Fd           | Y     |
| 12      | 45                 | 7.2 x 5.0         | 5.2 x 2.5         | Oblg  | Fd           | Y     |
| 12      | 34                 | 6.1 x 4.5         | 4.5 x 2.5         | Ov    | Fd           | Y     |
| 12      | 31                 | 6.5 x 4.2         | 4.8 x 2.3         | Oblg  | Fd           | Y     |

| <u>Row No.</u> | <u>Firmness</u> | <u>Soluble Solids</u> | <u>Flesh</u> |       |       |
|----------------|-----------------|-----------------------|--------------|-------|-------|
|                | (Lbs.)          | (%)                   | Taste        | Aroma | Color |
| 14             | 2.5             | 6.5                   | I            | None  | LG    |
| 14             | 2.5             | 9.0                   | I            | None  | LG    |
| 14             | 3.5             | 7.5                   | I            | Sweet | LG    |
| 14             | 2.0             | 10.0                  | I            | None  | LG    |
| 13             | 2.5             | 9.5                   | I            | None  | LG    |
| 13             | 4.5             | 6.0                   | I            | None  | LG    |
| 13             | 2.5             | 9.0                   | I            | None  | LG    |
| 13             | 4.5             | 7.5                   | I            | None  | LG    |
| 12             | 3.5             | 5.5                   | I            | None  | LG    |
| 12             | 3.0             | 6.5                   | I            | None  | LG    |
| 12             | 3.5             | 6.5                   | I            | None  | LG    |
| 12             | 4.0             | 8.5                   | I            | None  | LG    |

SIZE AND QUALITY OBSERVATIONS

(16 x PI<sub>2</sub>) x 16

BLACKSBURG, VA. 9-21-57

| <u>Row No.</u> | <u>Weight</u><br>(Ounces) | <u>Dimensions</u> |              | <u>Shape</u> | <u>Fruit</u>   |              |
|----------------|---------------------------|-------------------|--------------|--------------|----------------|--------------|
|                |                           | <u>Outer</u>      | <u>Inner</u> |              | <u>Texture</u> | <u>Color</u> |
|                |                           | <u>(Inches)</u>   |              |              |                |              |
| 13             | 56                        | 7.2 x 5.2         | 4.7 x 3.0    | Ov           | Fd             | Y            |
| 13             | 68                        | 7.2 x 5.5         | 5.0 x 2.7    | Oblg         | Nd             | Y            |
| 13             | 39                        | 7.0 x 4.7         | 4.7 x 2.7    | Ov           | Fd             | Y            |
| 13             | 45                        | 6.0 x 5.0         | 4.0 x 2.7    | Oblg         | Nd             | Y            |
| 12             | 64                        | 8.0 x 5.5         | 5.2 x 2.7    | Ov           | Nd             | Y            |
| 12             | 54                        | 7.5 x 5.0         | 5.2 x 2.7    | Oblg         | Fd             | Y            |
| 12             | 47                        | 7.2 x 5.0         | 5.0 x 2.7    | Oblg         | Fd             | Y            |
| 12             | 51                        | 7.5 x 5.0         | 5.0 x 2.7    | Ov           | Fd             | Y            |

| <u>Row No.</u> | <u>Firmness</u><br>(Lbs.) | <u>Soluble Solids</u><br>(%) | <u>Taste</u> | <u>Flesh</u> |              |
|----------------|---------------------------|------------------------------|--------------|--------------|--------------|
|                |                           |                              |              | <u>Aroma</u> | <u>Color</u> |
| 13             | 4.0                       | 6.5                          | I            | Sweet        | LG           |
| 13             | 3.5                       | 8.5                          | I            | None         | LG           |
| 13             | 2.0                       | 5.5                          | I            | None         | LG           |
| 13             | 3.5                       | 7.5                          | I            | Sweet        | LG           |
| 12             | 2.0                       | 7.5                          | I            | Sweet        | LG           |
| 12             | 2.5                       | 6.5                          | I            | None         | LG           |
| 12             | 2.5                       | 6.5                          | I            | None         | LG           |
| 12             | 3.0                       | 7.0                          | I            | None         | LG           |

SIZE AND QUALITY OBSERVATIONS

(16 x PI<sub>3</sub>) x 16

WARSAW, VA. 8-20-57

| <u>Row No.</u> | <u>Weight</u><br>(Ounces) | <u>Dimensions</u> |              | <u>Shape</u> | <u>Fruit</u>   |              |
|----------------|---------------------------|-------------------|--------------|--------------|----------------|--------------|
|                |                           | <u>Outer</u>      | <u>Inner</u> |              | <u>Texture</u> | <u>Color</u> |
|                |                           | <u>(Inches)</u>   |              |              |                |              |
| 15             | 57                        | 6.0 x 6.0         | 4.0 x 3.2    | Rd           | Sm             | Y            |
| 15             | 38                        | 9.0 x 4.0         | 6.7 x 3.2    | Elg          | Fd             | Y            |
| 15             | 67                        | 8.5 x 5.2         | 6.5 x 2.6    | Elg          | Fd             | Y            |
| 16             | 47                        | 6.0 x 5.2         | 4.1 x 2.6    | Ov           | Fd             | Y            |
| 16             | 67                        | 7.8 x 5.7         | 5.5 x 3.0    | Ov           | Fd             | Y            |
| 16             | 60                        | 7.1 x 5.5         | 4.7 x 2.6    | Ov           | Fd             | Y            |
| 17             | 52                        | 5.3 x 5.7         | 3.7 x 3.2    | Oblt         | Sm             | Y            |
| 17             | 34                        | 4.8 x 4.8         | 3.2 x 2.5    | Rd           | Sm             | Y            |
| 17             | 63                        | 6.5 x 5.7         | 4.5 x 3.2    | Rd           | Sm             | Y            |
| 17             | 29                        | 5.2 x 4.5         | 3.2 x 2.5    | Ov           | Sm             | Y            |

BLACKSBURG, VA. 9-21-57

|    |    |           |           |      |    |   |
|----|----|-----------|-----------|------|----|---|
| 12 | 46 | 7.0 x 4.7 | 4.5 x 2.7 | Ov   | Nd | Y |
| 12 | 46 | 7.0 x 5.2 | 4.7 x 3.0 | Oblg | Nd | Y |

| <u>Row No.</u> | <u>Firmness</u><br>(Lbs.) | <u>Soluble Solids</u><br>(%) | <u>Taste</u> | <u>Flesh</u> |              |
|----------------|---------------------------|------------------------------|--------------|--------------|--------------|
|                |                           |                              |              | <u>Aroma</u> | <u>Color</u> |
| 15             | 2.5                       | 9.0                          | I            | None         | LG           |
| 15             | 1.5                       | 6.0                          | I            | None         | LG           |
| 15             | 2.0                       | 7.0                          | I            | None         | LG           |
| 16             | 2.5                       | 7.0                          | I            | None         | LG           |
| 16             | 2.5                       | 6.5                          | I            | Sweet        | LG           |
| 16             | 1.0                       | 8.5                          | S            | Sweet        | LG           |
| 17             | 2.0                       | 10.5                         | I            | None         | LG           |
| 17             | 4.5                       | 6.0                          | A            | None         | LG           |
| 17             | 2.0                       | 7.0                          | I            | Sweet        | LG           |
| 17             | 1.0                       | 3.5                          | I            | None         | LG           |

BLACKSBURG, VA. 9-21-57

|    |     |      |   |       |    |
|----|-----|------|---|-------|----|
| 12 | 3.5 | 10.0 | S | Sweet | LG |
| 12 | 3.0 | 8.0  | I | None  | LG |

SIZE AND QUALITY OBSERVATIONS

16 x (16 x PI<sub>4</sub>)

WARSAW, VA. 8-20-57

| <u>Row No.</u> | <u>Weight</u><br>(Ounces) | <u>Dimensions</u> |              | <u>Shape</u> | <u>Fruit</u>   |              |
|----------------|---------------------------|-------------------|--------------|--------------|----------------|--------------|
|                |                           | <u>Outer</u>      | <u>Inner</u> |              | <u>Texture</u> | <u>Color</u> |
|                |                           | <u>(Inches)</u>   |              |              |                |              |
| 18             | 43                        | 6.8 x 4.7         | 4.2 x 2.2    | Ov           | Fd             | YG           |
| 18             | 51                        | 7.7 x 4.7         | 5.5 x 2.2    | Oblg         | Fd             | Y            |
| 18             | 49                        | 7.5 x 4.7         | 5.5 x 2.7    | Oblg         | Fd             | Y            |
| 18             | 58                        | 8.7 x 4.7         | 6.7 x 2.2    | Oblg         | Fd             | Y            |
| 19             | 73                        | 9.7 x 5.0         | 7.0 x 2.2    | Oblg         | Fd             | YG           |
| 19             | 53                        | 10.2 x 4.1        | 8.0 x 2.0    | Elg          | Fd             | Y            |
| 19             | 57                        | 8.0 x 5.0         | 5.5 x 2.5    | Oblg         | Fd             | Y            |
| 20             | 58                        | 8.5 x 4.7         | 6.0 x 2.2    | Oblg         | Fd             | YG           |
| 20             | 25                        | 5.3 x 4.0         | 3.5 x 2.0    | Ov           | Fd             | Y            |
| 20             | 49                        | 6.7 x 5.2         | 4.3 x 3.0    | Ov           | Sm             | Y            |
| 20             | 65                        | 10.5 x 4.8        | 8.0 x 2.3    | Elg          | Fd             | Y            |

BLACKSBURG, VA.

|    |     |            |            |      |    |   |
|----|-----|------------|------------|------|----|---|
| 15 | 64  | 8.5 x 5.7  | 6.0 x 2.2  | Oblg | Nd | Y |
| 14 | 226 | 17.5 x 7.0 | 14.5 x 3.2 | Elg  | Nd | Y |
| 14 | 56  | 7.5 x 5.2  | 5.2 x 2.7  | Oblg | Nd | Y |
| 14 | 166 | 15.0 x 6.7 | 12.0 x 3.7 | Elg  | Nd | Y |

| <u>Row No.</u> | <u>Firmness</u><br>(Lbs.) | <u>Soluble Solids</u><br>(%) | <u>Taste</u> | <u>Flesh</u> |              |
|----------------|---------------------------|------------------------------|--------------|--------------|--------------|
|                |                           |                              |              | <u>Aroma</u> | <u>Color</u> |
| 18             | 1.5                       | 4.5                          | B            | None         | W            |
| 18             | 2.5                       | 4.5                          | I            | None         | LG           |
| 18             | 4.5                       | 6.0                          | I            | None         | LG           |
| 18             | 3.0                       | 4.5                          | I            | None         | LG           |
| 19             | 1.0                       | 5.0                          | B            | None         | LG           |
| 19             | 2.0                       | 5.0                          | B            | None         | LG           |
| 19             | 3.0                       | 7.0                          | I            | Sweet        | LG           |
| 20             | 1.0                       | 10.0                         | I            | None         | LG           |
| 20             | 3.5                       | 4.5                          | B            | None         | LG           |
| 20             | 0.5                       | 9.0                          | A            | None         | W            |
| 20             | 5.0                       | 7.5                          | I            | Sweet        | LG           |

BLACKSBURG, VA. 9-21-57

|    |     |     |   |      |    |
|----|-----|-----|---|------|----|
| 15 | 1.5 | 5.5 | B | None | LG |
| 14 | 2.0 | 6.0 | I | None | LG |
| 14 | 2.5 | 9.5 | B | None | LG |
| 14 | 2.5 | 6.5 | B | None | LG |