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TEXAS AGRICULTURAL EXPERIMENT STATION

A. B. CONNER, DIRECTOR
College Station, Brazos County, Texas

BULLETIN NO. 438 NOVEMBER, 1931

DIVISION OF HORTICULTURE

Tomato Varieties and Fertilizers for the Lower Rio Grande Valley of Texas

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**In cooperation with U. S. Department of Agriculture.
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Tomato production is one of the leading truck-gardening enterprises in the Lower Rio Grande Valley. The annual production of tomatoes has increased from 946 cars in 1926-27 to 2,927 cars for the 1930-31 season. Since the shipping season is short, early maturity of the crop is a most important factor. Shipping quality of the fruits is also an important consideration. The globe or round-type fruits are in better demand but these varieties are late and somewhat unprolific as compared with varieties like Bonny Best. Varieties of the semi-globe or oblate type are less productive and mature later than varieties of the flattened or oblong type, but are more desirable from the commercial standpoint than other types. Bonny Best, John Baer, Clark's Early, and similar varieties come under this classification and appear to be better adapted to this region than any of the other varieties studied.

An application of 20 tons of manure per acre increased the annual yield of marketable fruit by 2,000 pounds. Twelve hundred pounds per acre of 4-8-8 fertilizer gave decided increases in yield, but six-hundred-pound applications of the same fertilizer were not equal to applications of six hundred pounds per acre of superphosphate.

Pruning reduced the total yield of fruit, but increased the percentage of early marketable fruit.

Spacing the plants relatively close together increased the yield of early fruit, and did not materially reduce the size of the fruits.

"Pocketing" was more severe on some varieties than others, and was confined to individual plants in some instances. Fertilizers did not materially affect the percentage of "pocketed" fruits.

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BULLETIN NO. 438 NOVEMBER, 1931

TOMATO VARIETIES AND FERTILIZERS FOR THE LOWER RIO GRANDE VALLEY

W. H. FRIEND

The production of tomatoes during the late spring and early summer is one of the most important trucking enterprises of the irrigated portions of the counties comprising the Lower Rio Grande Valley. The car-lot production of this crop has ranged from 85 cars in 1920 to 2,927 cars in 1931. During the last six-year period, production has averaged approximately 1,000 cars for the first three years and more than 2,000 cars for the last three seasons. Thus, it will be seen that the tomato industry is rapidly expanding in this region (Table 1).

Tomato harvesting in the second early regions to the north of the Valley is usually well under way by the first week in June. In a late season there may be an overlapping of the harvesting periods of the two regions, and in such an event, the Valley producers, because they are further removed from the markets, are at a disadvantage. The fact that the shipping season is fairly well defined makes it desirable for the Valley growers to get their tomatoes on the market relatively early. Further, the fact that the producing areas are far removed from the points of consumption makes it necesasry that the tomatoes hold up well in transit.

Methods of Growing Tomatoes in the Lower Rio Grande Valley

Tomatoes are grown on soils ranging from the light sandy loams to clay loams and clays. Because the heavier soils are more retentive of moisture and require less irrigation, and because vegetative growth is much less on heavy soils than on the light sandy loam soils, many growers prefer the heavier soils for tomato production.

A most important point in selecting a location for a planting of tomatoes is consideration of the crop previously grown. It is highly important that tomatoes be rotated with unrelated crops, and crops that are not subject to the same pests and diseases. It is unwise to follow potatoes, egg plant, or peppers with tomatoes because these plants are rather closely related. It is also unwise to plant tomatoes on ground known to be infested with nematodes.

Since early fall and winter vegetables are usually planted on land previously in corn or spring vegetables, tomatoes are usually grown on land that grew cotton during the previous season. This is a very good practice, especially where the stalks are plowed under early in the fall.

The land for tomatoes is usually plowed, disked, floated, and then listed into rows thirty-six to forty-eight inches apart. If fertilizer is

to be used, it is applied in the bottom of the furrows and mixed with the soil with a cultivator before irrigation water is applied.

A timely rain may make the use of irrigation water unnecessary in starting the seedlings off, but since the plants are started during the dry season, it is much the safer policy to water the land *before* the seeds are planted. This watering is usually done about two weeks before the seeds are to be planted.

Since earliness is a most important factor in the production of tomatoes, it is the common practice for growers to start the spring crop during the latter part of December. In recent years there has been a tendency to advance the time of planting to early December. Since the average date of the last killing frost is about February 18, the earlier plantings encounter much more serious frost hazards than do the January plantings.

The young plants are most effectively protected by being planted twice as close together as is required for a permanent stand, then when weather forecasts indicate that there is danger of a killing frost, each alternate plant should be covered with soil. Should the frost fail to materialize, no effort is made to uncover the plants which were covered with soil, and dependence must then be had upon the single stand remaining uncovered; of course, if the frost kills the unprotected plants then the alternate plants may be uncovered and will be earlier than plantings made after the frost. The older and larger plants are protected by this method with more difficulty, and for this reason extra early seeding makes the enterprise more hazardous from the standpoint of loss from frost.

Dry "northers" frequently sweep the country during the times when spring tomato plants are developing and cause considerable damage to the plants, both by actual desiccation and by whipping the plants about and bruising the succulent stems and foliage. The use of temporary windbreaks between the rows of tomatoes is of great benefit in protecting them from damaging winds. A great deal of protection during the windy season can be afforded by annual white sweet clover (Hubam), cabbage, beets, or early squash. Corn does not develop early enough to be of much benefit and may shade the plants too much, especially where it is planted in alternate rows.

The actual planting of the seed is usually done with a vegetable seeder; however, some prefer to plant the seed in hills by hand. Where planting is done on a firm, moist seed bed, germination is quite rapid and the plants grow off at a fairly rapid rate.

When the plants are six to eight inches in height, the first thinning is done. Hills of four to six plants are allowed to remain until the plants have attained a height of ten to twelve inches, or until it is thought that the danger of cutworms is past. At the final thinning, the plants which are allowed to remain are left singly in hills and two to three feet apart in the rows. Close spacing of the plants in the row and the crowding together of the rows will lessen the injury from

wind, but in the case of the vigorous growing varieties may cause the fruit to be shaded too much.

It is not the common practice to prune tomatoes in this region; however, much interest has been shown in this practice during recent years. Keeping the vines pruned to three main stems until the first three or four clusters of fruit are set is probably the best method of pruning under Valley conditions.

It has already been pointed out that the application of about four acre inches of water should precede the planting of the crop. An additional ten acre inches of water, either as rainfall or irrigation, should be sufficient for a crop under normal conditions. The plants should not be allowed to suffer for moisture, especially during the month of March.

Table 1. Tomato shipments from the lower Rio Grande Valley, 1919-1931

Season	Car-Loads Shipped*
1919	91
1920	85
1921	455
1922	116
1923	110
1924	288
1925	324
1926	925
1927	946
1928	1,357
1929	1,906
1930	2,272
1931	2,927

*Express shipments included in these figures

Cultivation starts when the plants are large enough to have soil worked to them and should be continued as often as necessary to keep weeds under control. Sled cultivators may be used for the first one or two cultivations, but sweep cultivators of the horse-hoe type are most generally used.

Hoeing should be resorted to whenever necesary in order that weeds be kept under control. The timely use of hoes will do much to keep the crop free of weeds and will thereby reduce the work of harvesting.

Spraying or dusting to control insect pests and diseases has not been practiced very generally in the Valley. A sporadic outbreak of late blight in the 1931 crop has done much to stimulate interest in this phase of tomato culture.

The use of a combination spray containing Bordeaux (4-4-50), arsenate of lead (1-50), and nicotine sulphate (1-1000) is probably the best material to use in protecting the vines and crop. Most of the spraying should be done relatively early in the life of the plant, as late spraying may result in some stained fruit. Fungicidal-insecticidal dusts may be used to combat insect pests and diseases of the tomato, but have been observed to be less effective than the liquid sprays.

Harvesting the crop starts when the first fruits are in the "mature green" stage. At this stage the intra-locular mass is in a semi-liquid or jelly-like state and almost fills the cavity. When this substances has a dry appearance, the fruit is immature and will not ripen properly after it has been removed from the vine. The bulk of the crop ripens during May, but this may vary one or two weeks either way, according to the season.

VARIETY EXPERIMENTS WITH TOMATOES

Plan of Experiments

The variety studies with tomatoes at the Valley Station were initiated in 1924 for the purpose of obtaining information over a period of years in regard to the performance of the different varieties under conditions existing in the Lower Rio Grande Valley. Certain varieties were studied for a single season only, while others of greater importance to this region were included throughout the entire period. The varieties studied were compared with a check variety, which was the one most widely grown commercially at the time the experiments were started.

Conditions of the Experiments With Varieties

The tomato variety experiments were conducted on Victoria Fine Sandy Loam soil (6, 7, 8). This is not the soil type on which the greater portion of the Valley tomato crop is produced, but most of the expansion in tomato growing is being made on sandy loam soil. It has been observed that certain varieties behave differently when planted on different kinds of soil. This fact should be taken into consideration in making practical application of the results presented in this bulletin.

The tomato plants used in the variety work were grown in rotation with spring and winter truck crops, and with summer crops of cotton and corn. The usual method of plowing, disking, floating, listing, and irrigating the land in preparation for planting was followed.

Seed used in the experiments was obtained from the original growers in most instances, and was obtained from the same source from year to year, except where several strains of the same variety were included in the experiment. Commercial seed was used; not selected stocks furnished especially for experimental planting.

In growing the crop, the seed was planted at one side of the water furrow in rows six feet apart. Seeding was usually done during the early part of January. Plants were thinned to three plants per hill when they were approximately six inches in height. Final thinning to one plant every three feet was done when it was thought that cutworm danger was past. The plantings were cultivated as often as necessary to keep weeds under control. Irrigation water was applied during the growth period, at such times as soil-moisture conditions indi-

cated that a need for additional soil moisture existed or would exist within a short time.

The plats used in this work were arranged so that the rows of plants were six feet apart, each row of 44 hills constituting a plat 1/55-acre in size. Due to the fact that wide spacing between the rows was followed, buffer rows between the variety plats were not used. In most cases, every fifth plat was planted to the check variety. While the soil on the experimental plats seems quite uniform, the productive capacity of the field varies considerably. For this reason, yield records of the different varieties are compared with the average yield of the two nearest check plats rather than with the average yield of all of the check plats.

Method of Measuring Varietal Characteristics

In recording data concerning the different varieties, actual yields were taken on a plat basis. Characteristics such as color, shape, relative size, pocketing, and regularity of fruit, season of maturity, and vine characters were determined on a percentage basis. Measurements such as diameter and length of fruit, thickness of wall, and average weight of fruit were determined by actual measurement of not less than twenty fruits, which were picked in the "pink" stage.

The adaptability characteristics, other than yield of fruit, are probably more important in evaluating the desirability of a variety for use in the Valley than is yielding capacity, as determined by the plat method. Most of the varieties studied were prolific. The kind of fruit produced and the season at which the fruit matures are more important than gross tonnage of fruit. Yield of marketable fruit is included and will give some idea concerning the quality of the crop, especially in regard to size and shape of the fruit. The percentage of "pocketed" fruit may also be considered as a measure of quality.

"Pocketing" or "puffing," a condition in which the jelly-like tissues in the seed cavities fail to fill the entire locule, is a most important point to consider in arriving at the relative value of the tomato varieties. The classification of Traub, Hotchkiss, and Johnson (9) is used in indicating the severity of pocketing.

Fruit colors refer to Ridgway's Color Chart (5). Only two color groupings, scarlet red and pomegranate purple, are made in classifying the varieties.

Shape is designated as (1) round or globular, (2) oblate or flattened globular, and (3) oblong or flattened. Regularity of shape was determined on a percentage basis. Where less than sixty per cent of the crop failed to conform to the varietal type, the strain was designated as "very irregular"; where less than seventy but more than sixty per cent conformed to the varietal type, the designation was "irregular," and where more than seventy per cent of the crop conformed to the variety type, the designation was "regular."

"Season of maturity" was determined on the basis of the period dur-

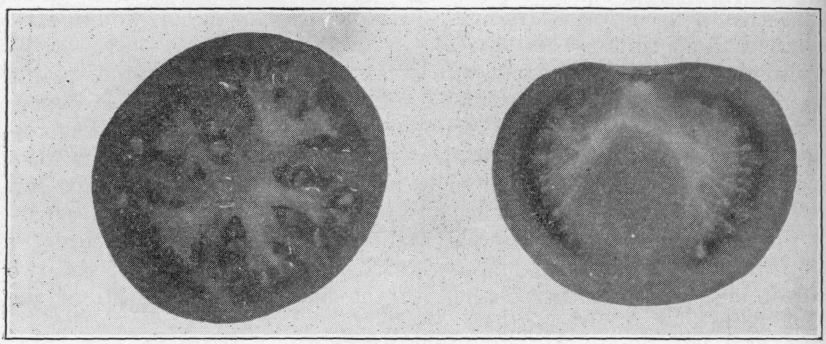

Fig. 1. Tomato fruits of the globe type. Note the small amount of inter-locular tissue present, giving the fruit a seedy appearance.

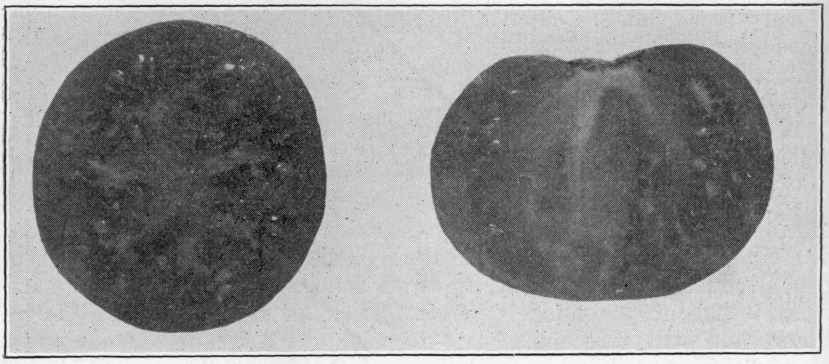

Fig. 2. Tomato fruits of the oblate type. Note that the inter-locular tissue is more pronounced than in the case of the globe type fruit.

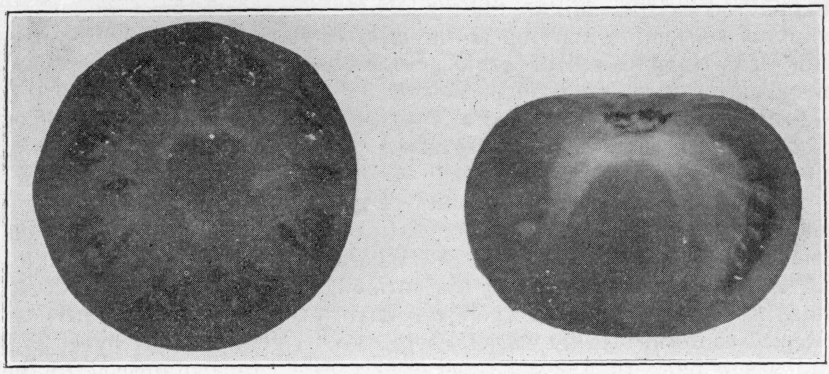

Fig. 3. Tomato fruits of the oblong or flattened type. Note that there is an abundance of inter-locular tissue, giving the fruit a meaty appearance.

ing which the bulk of the crop for each of the strains matured, and not on the basis of the ripening period of a few early fruits.

Vine characters indicate the relative size of the vines, leafiness, and habit of growth. Protection afforded the fruit is one of the important factors in the consideration of these characters.

Classification of Varieties

A method of classification which emphasizes shape as well as color has been presented in this publication and differs in that respect from the classification proposed by Halstead (2). The one emphasizing shape of fruit should be of practical value to the grower in that it lists those varieties having the most desirable shape, those having the least desirable shape, and those intermediate between the other two groups. Since this character is a most important consideration in the commercial grading of fruit, varieties producing fruit which is round or globular are the most desirable, other factors being equal.

Only three botanical varieties of *Lycopersicum esculentum* (1) are considered in the present classification:

A. *L. esculentum* var. *commune*. Fruit usually large; standard foliage; spreading habit of growth. Most commercial types of tomatoes.

B. *L. esculentum* var. *validum*. Thick, short stems; upright growth; foliage very dark green; short and dense. Dwarf tomatoes.

C. *L. esculentum* var. *grandifolium*. Foliage with entire margins resembling potato foliage; plants of spreading habit; fruit large and multicolor. Potato-leaved tomatoes.

The varieties are classified as to color under each of the following shape classes:

(1) Fruit oblate or compressed spherical;
(2) Fruit round or spherical; and
(3) Fruit oblong or flattened.

Table 2. Classification of varieties based on color and shape of fruit

Group A. Lycopersicum esculentum var. commune (Most commercial types of tomatoes)

1. Fruits Oblate in Shape.
   (a) Scarlet-Red Color.
   A and M First Early
   Avon Early
   Break O' Day
   Burbank
   Bonny Best
   Clarks Early
   Chalk's Early Jewel
   Hummer
   John Baer
   Livingston's Favorite
   Matchless
   Manyfold
   Norton
   Norduke
   Perfection
   Perfect First Early
   Viking
   Stone

   (b) Pomegranate-Purple Color.
   Acme
   Beauty
   Boulder
   Early Detroit
   Fordhook First Early
   Louisiana Pink
   Marvelosa
   Trucker's Favorite

2. Fruits Round in Shape.

   (a) Scarlet-Red Color.
   Fargo
   Long Keeper
   Louisiana Red
   Marglobe
   Red Head

   (b) Pomegranate-Purple Color.
   Cooper's Special
   Coreless
   Early Shipper
   Globe
   Gulf State Market
   Kanora
   King of the Earlies
   Rosy Morn
   Self Topper

3. Fruits Oblong in Shape.
   (a) Scarlet-Red Color.
   Duke of York
   Earliana
   Early Michigan
   New Prolific
   Paragon
   Winter Queen

   (b) Pomegranate-Purple Color.
   Blackland
   Brimmer
   June Pink

Group B. L. esculentum var. validum (Dwarf tomatoes)

1. Fruits Oblate in Shape.
   (a) Scarlet-Red Color
   Dwarf Champion

   (b) Pomegranate-Purple Color.
   Dwarf Giant

2. Fruits Round in Shape.
   (a) Scarlet-Red Color.
   Dwarf Stone

3. Fruits Oblong in Shape.
   (a)
   (b) Pomegranate-Purple Color.
   Giant Tree

Group C. L esculentum var. grandifolium (Potato leaved tomatoes).

1. Fruits Oblate in Shape.
   (a)

2. Fruits Round in Shape.
   (a)
   (b) Pomegranate Color.
   Magnus

3. Fruits Oblong in Shape.
   (a)
   (b) Pomegranate-Purple Color.
   Mikado

Results of Variety Experiments

The tomato varieties included in the experiments during the period from 1925 to 1930, inclusive, are classified in Table 2. It should be noted that most of the varieties produce fruit which is either oblate in shape or flattened; comparatively few varieties produce the highly desirable, globe-shaped, or spherical fruits. Color is not so important as shape in determining the worth of a variety; but where other factors are equal, the purple-fruited sorts are more desirable than are the scarlet-fruited varieties. Purple fruited tomatoes develop a more attractive color when ripened off the vines than do the average run of scarlet-fruited varieties, especially where the yellow under color is strongly pronounced.

COMMERCIAL DESIRABILITY OF TOMATO VARIETIES

Probably the most important consideration in determining the suitability of a variety of tomatoes for commercial use concerns uniformity in the shape of the fruit.

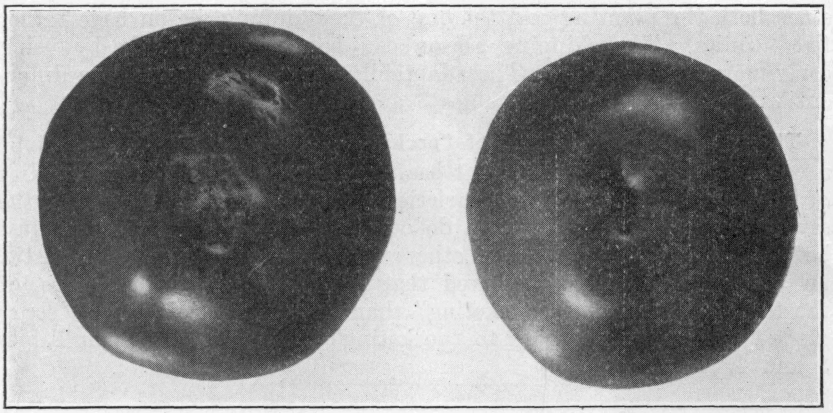

Fig. 4. Two types of blemishes common to most commercial varieties of tomatoes.

Shape, Size, and Shipping Quality of Fruit

Factors such as diameter of fruit, length of fruit, thickness of wall, average weight, and severity of pocketing, as they are operative in determining shape, size, and shipping quality of fruit, are of first importance. This importance is due to the decided market demand for spherical fruits of medium size that hold up well in transit. The ratio of length to diameter, when considered along with regularity of shape, gives one an accurate conception concerning the nature of the fruit. Neither extreme in regard to size is desirable, from the standpoint of the commercial producer. Tomatoes larger in diameter than three inches and weighing 0.4 pound (approximately 6½ ozs.) are too large to be commercially desirable, while fruit smaller than one and one-half inches in diameter and weighing less than 0.1 pound each are too small for market.

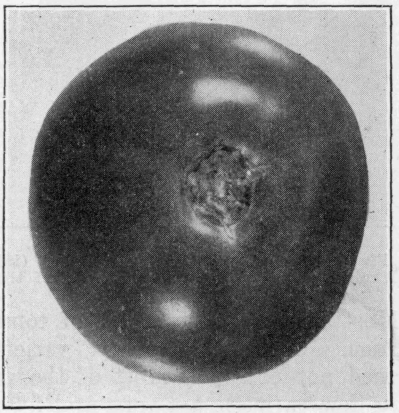

Fig. 5. A desirable type of basin on globe-shaped fruit. Note the absence of furrows and cracks.

The relative size of the fruit is of importance in rating the varieties for the reason that both very large and small tomatoes are undesirable from a commercial standpoint. Medium-size tomatoes are the most desirable and are in greatest demand on the market.

Earliness of maturity is an important factor in tomato production, since both the planting and the end of the shipping season have rather fixed limits. The shipping season can be lengthened only by using early-maturing varieties. The adaptability characteristics of the different varieties are shown in Tables 3 and 4.

The amount or percentage of "pocketing" or puffy fruit produced by a variety has a rather important bearing on the commercial desirability of that variety. Since some varieties produce more fruit showing the severe forms of pocketing than do other varieties, these varieties must be considered inferior to the others in regard to this characteristic. In general, it has been observed that the more "meaty" tomatoes, of the flat type, show less "pocketing" than do tomatoes of the less seedy globe type. Data in regard to "pocketing" are also presented in Tables 3 and 4.

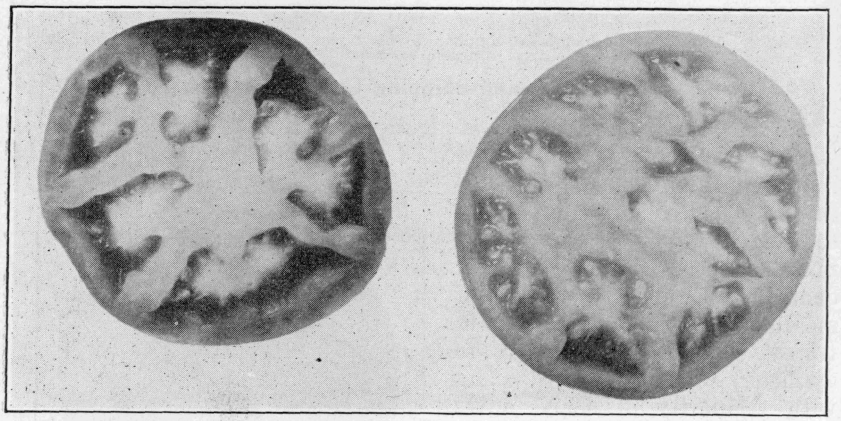

Fig. 6. Normal (right) and pocketed (left) tomato fruits. Note the small number of relatively large locules in the case of the pocketed fruit.

Most commercial varieties of tomatoes yield well under normal conditions. Comparatively few varieties are so unproductive as to be termed not prolific. Most of the varieties observed are prolific, while some few varieties are very prolific. In arriving at the yielding capacities of the varieties, quality of the crop must be given due consideration. It is not possible to use the same standard for grading all of the varieties. In grading for shape, the standard for tomatoes of the oblong or flattened type would be decidedly different from that of round or globe-type tomatoes.

Table 3. Fruit characteristics of tomato varieties*.

Variety	Length, Inches	Diameter, Inches	Thickness of Wall, Inches	Average Weight, lbs.	Number of "Pocketed" Fruits			
					(Severe)	(Moderate)	(Slight)	(Very Slight)
Avon Early	2.0	2.5	0.2	0.31	.....	None pocketed	.....	.....
Bonny Best	2.0	2.6	0.21	0.35	13	7	.....	.....
Clark's Early	2.0	2.6	0.2	0.34	.....	None pocketed	.....	.....
Cooper's Special	2.2	2.7	0.3	0.41	6	5	1	1
Earliana	2.0	2.7	0.2	0.35	2	.....	.....	.....
Fargo	1.7	2.1	0.2	0.22	2	.....	.....	.....
First Early	2.0	2.8	0.2	0.38	.....	None pocketed	.....	.....
Globe	2.1	2.5	0.3	0.32	4	6	3	2
Gulf State Market	2.1	2.6	0.2	0.33	3	.....	.....	.....
John Baer	2.0	2.7	0.2	0.36	4	.....	.....	.....
Louisiana Pink	2.1	2.7	0.2	0.35	9	.....	2	.....
Marglobe	2.2	2.8	0.2	0.40	8	11	.....	.....
Norton	2.0	2.7	0.2	0.35	8	11	.....	.....
Nicholson 498	2.1	2.7	0.2	0.38	.....	None pocketed	.....	.....

*20 fruits harvested in "pink" stage, season of 1930.

Table 4. Adaptability characteristics of tomato varieties.

Variety	Uniformity of Fruit	Size Rating	Season of Maturity	Pocketing	Vines	Leaves	Yield Rating	No. of Seasons
A and M First Early	Irregular	Medium	Early	Slight	Open	Medium	Prolific	2
Avon Early	Irregular	Medium	Very early	Slight	Open	Medium	Prolific	5
Acme	Irregular	Medium	Midseason	Slight	Med. dense	Medium	Not prolific	2
Bonny Best	Slightly irregular	Medium	Midseason	Severe	Med. dense	Medium	Prolific	2
Burbank Early	Irregular	Small	Very early	Moderate	Open	Medium	Very prolific	5
Boulder	Irregular	Medium	Midseason	Slight	Med. dense	Medium	Not prolific	1
Beauty	Irregular	Medium	Midseason	Slight	Med. dense	Medium	Not prolific	3
Break O' Day	Regular	Large	Early	Medium	Slightly open	Small	Very prolific	1
Brimmer	Irregular	Large	Late	Slight	Dense	Medium	Not prolific	2
Cooper's Special	Regular	Medium	Midseason	Severe	Med. dense	Small	Very prolific	7
Coreless	Irregular	Medium	Late	Severe	Dense	Medium	Not prolific	1
Clark's Early	Slightly irregular	Medium	Midseason	Slight	Med. dense	Medium	Prolific	3
Duke of York	Regular	Small	Midseason	Slight	Med. dense	Medium	Not prolific	3
Dwarf Champion	Regular	Medium	Late	Slight	Dense	Large	Not prolific	2
Dwarf Giant	Very irregular	Medium	Midseason	Severe	Dense	Large	Not prolific	1
Dwarf Stone	Regular	Medium	Late	Severe	Dense	Medium	Not prolific	1
Early Detroit	Regular	Medium	Midseason	Slight	Med. dense	Medium	Not prolific	4
Early Michigan	Very irregular	Medium	Early	Slight	Med. dense	Medium	Prolific	1
Early Shipper	Irregular	Medium	Early	Slight	Med. dense	Medium	Not prolific	1
Earliana	Irregular	Medium	Very early	Slight	Open	Small	Very prolific	3
Fordhook First Early	Irregular	Medium	Early	Slight	Med. dense	Medium	Prolific	3
Fargo	Regular	Very small	Very early	Slight	Open small	Small	Very prolific	3
First Early	Irregular	Medium	Very early	Slight	Open	Medium	Very prolific	3
Globe	Regular	Medium	Late	Slight	Dense	Large	Not prolific	10
Gulf State Market	Regular	Medium	Midseason	Slight	Dense	Large	Prolific	9
Giant Tree (Dwarf)	Irregular	Medium	Late	Severe	Dense	Large	Not prolific	1
Greater Baltimore	Very irregular	Large	Late	Slight	Dense	Large	Med. prolific	1
Hummer	Irregular	Medium	Late	Mod. severe	Med. dense	Medium	Not prolific	1
Improved Black Land	Irregular	Medium	Late	Slight	Med. dense	Medium	Prolific	1
John Baer	Slightly irregular	Medium	Midseason	Slight	Med. dense	Medium	Very prolific	5
June Pink	Irregular	Medium	Early	Slight	Open	Small	Very prolific	7
Kanora	Irregular	Medium	Midseason	Slight	Med. dense	Medium	Not prolific	1
King of the Earlies	Irregular	Medium	Early	Slight	Med. dense	Medium	Prolific	1
Livingston's Favorite	Irregular	Medium	Midseason	Slight	Med. dense	Medium	Med. prolific	1
Louisiana Pink	Irregular	Medium	Midseason	Mod. severe	Med. dense	Medium	Very prolific	7
Long Keeper	Irregular	Medium	Midseason	Slight	Med. dense	Medium	Med. prolific	1
Louisiana Red	Slightly irregular	Medium	Midseason	Severe	Med. dense	Medium	Very prolific	1
Manifold	Irregular	Medium	Late	Slight	Med. dense	Medium	Very prolific	1
Matchless	Regular	Medium	Late	Slight	Med. dense	Medium	Prolific	1
Marvalosa	Regular	Medium	Midseason	Slight	Med. dense	Medium	Prolific	2
Marglobe	Slightly irregular	Medium	Late	Severe	Dense	Large	Med. Prolific	7
Magnus (Potato Leaved)	Irregular	Medium	Midseason	Mod. severe	Dense	Large	Not prolific	2

Mikado (Potato Leaved)	Very irregular	Medium	Midseason	Mod. Severe	Med. dense	Medium	Not prolific	1
Norduke	Irregular	Medium	Late	Severe	Med. dense	Medium	Not prolific	1
Norton	Regular	Medium	Late	Slight	Dense-Large	Large	Not prolific	7
Nicholson 498	Regular	Medium	Midseason	Slight	Med. dense	Large	Prolific	1
New Prolific	Irregular	Medium	Early	Slight	Medium	Medium	Prolific	1
Perfect First Early	Regular	Medium	Early	Slight	Open-Med	Medium	Prolific	3
Perfection	Irregular	Medium	Late	Slight	Med. dense	Medium	Not prolific	1
Paragon	Irregular	Medium	Midseason	Severe	Med. dense	Medium	Not prolific	1
Red Head	Regular	Small	Early	Mod. severe	Med. dense	Medium	Prolific	2
Rosy Morn	Irregular	Medium	Midseason	Severe	Med. dense	Medium	Not prolific	4
Santa Clara Canner	Very irregular	Large	Very late	Slight	Dense	Large	Med. prolific	1
Stone	Irregular	Medium	Late	Slight	Dense	Large	Not prolific	3
Self pruning	Regular	Medium	Midseason	Severe	Med. dense	Medium	Very prolific	2
Self Topping	Regular	Medium	Midseason	Severe	Med. dense	Small	Very prolific	2
Trucker's Favorite	Irregular	Medium	Early	Slight	Med. dense	Medium	Not prolific	2
Viking	Irregular	Medium	Midseason	Slight	Small-Med. dense	Medium	Prolific	2
Winter Queen	Irregular	Medium	Early	Slight	Open	Small	Very prolific	1

Habit of Growth: The vine characteristics of the different varieties are of importance, as they affect the shading of the fruit. Most varieties of tomatoes, when grown under Valley conditions, produce vines of considerable height and spread. Some varieties have relatively small leaves and the plant has an open habit of growth, while plants of the

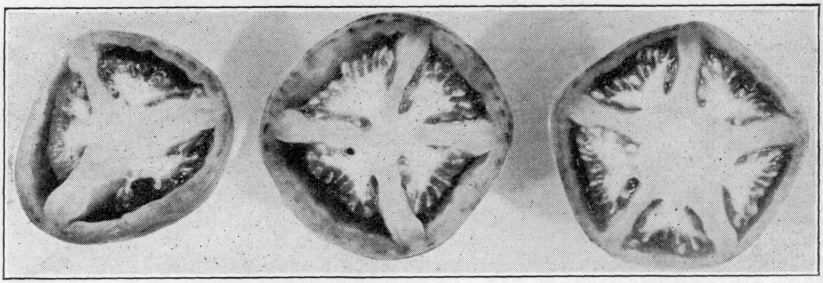

Fig. 7. Marked angularity of tomato fruits due to pocketing.

other varieties may have large leaves and a dense habit of growth. Fruit on the open type of vines may not receive sufficient protection and may be subject to sunburn, while those on dense vines may be unduly shaded and their normal development and maturity proportionately retarded.

Table 5. Annual yields for tomato varieties, 1925

Variety	Average yield per plant Pounds	Average yield per plant of nearest check* Pounds	Increase (+) or Decrease (—) over Nearest check* Yield per acre Pounds
A and M First Early	2.62	2.84	— 1,064
Avon Early	2.70	1.96	+ 3,581
Brimmer	1.66	3.61	— 9,438
Boulder	1.75	2.84	— 5,175
Bonny Best	2.89	1.96	+ 3,951
Crown Picked Globe	2.68	4.24	— 7,550
Dwarf Stone	2.11	3.61	— 7,260
Dwarf Champion	1.79	2.84	— 5,082
Early Detroit	2.59	3.15	— 2,710
Early Shipper	2.27	4.24	— 9,534
Gulf State Market	3.63	4.24	— 2,952
Giant Tree	2.59	3.61	— 4,936
Improved Black Land	3.22	3.15	+ 338
King of the Earlies	3.93	4.24	— 1,500
Livingston Globe	3.39	4.24	— 4,114
Livingston's Favorite	3.23	4.24	— 4,888
Norton	1.87	3.61	— 7,411
New Prolific	.89	3.15	— 6,098
Perfect First Early	3.42	2.84	+ 2,807
Red Field Beauty	1.26	3.15	— 9.147
Rosy Morn	2.13	4.24	—10,112
Spark's Earliana	3.27	3.15	+ 580
Winter Queen	3.59	3.15	+ 2,129

*Check—June Pink.

Table 6. Annual yields for tomato varieties, 1926.

Variety	Average yield per plant Pounds	Average yield per plant of nearest check* Pounds	Increase (+) or Decrease (—) over Nearest check* Yield per acre Pounds
Avon Early	15.97	7.47	+10,285
A and M First Early	13.83	10.73	+ 3,751
Acme	8.80	10.73	— 2,335
Burbank	17.25	7.51	+21,809
Beauty	5.25	9.81	— 5,517
Brimmer	3.24	7.70	— 5,396
Cooper's Special	13.86	7.60	+ 6,364
Coreless	1.35	9.81	—10,236
Early Detroit	5.10	7.60	— 3,025
Early Michigan	5.19	7.51	— 2,807
Earliana (Spark's)	10.25	7.51	+ 3,315
Fordhook First Early	11.89	9.81	+ 2,516
Globe	10.64	11.10	— 556
Gulf State Market	9.62	10.27	— 786
Hummer	5.44	7.51	— 2,504
John Baer	11.75	10.85	+ 1,089
June Pink	14.18	9.81	+ 5,287
Louisiana Pink	14.86	9.81	+ 6,110
Manifold	15.06	9.81	+ 6,352
Matchless	4.73	9.81	— 6,146
Norduke	2.15	7.51	— 6,485
Norton	5.26	9.81	— 5,505
Perfection	8.41	9.81	— 1,694
Perfect First Early	8.23	10.73	— 3,025
Paragon	3.68	10.73	— 8,530
Red Head	11.88	9.81	+ 2,504
Rosy Morn	7.66	9.81	— 2,601
Self Pruning	11.55	7.44	+ 4,973
Trucker's Favorite	10.50	8.66	+ 2,226

*Check—Livingston's Globe (L).

Yields of Various Varieties

Total yield of marketable fruit produced is an important consideration in arriving at the commercial value of a variety. The factor of shape of fruit as it affects grade should be given due weight, however, in interpreting any lot of yield data. Yield in one shape class may not have the same relative value as a similar yield figure in another shape class. For example, five tons per acre of round tomatoes may be worth considerably more from the commercial standpoint than a similar yield of either oblate-shaped or flattened tomatoes. Data in regard to annual yields are presented in Tables 5, 6, 7, 8, 9, 10, and 11.

Table 7. Annual yields for tomato varieties, 1927

Variety	Average yield per Plant Pounds	Average yield per plant of nearest check* Pounds	Increase (+) or Decrease (—) over Nearest check* Yield per acre Pounds	Marketable fruit Per cent
Acme	1.11	2.98	—2,262	84
Burbank	5.33	.71	+5,590	70
Beauty No. 1	1.47	2.98	—1,827	61
Beauty No. 2	4.98	2.98	+2,420	86
Beauty No. 3	.55	2.98	—2,940	67
Beauty No. 4	1.90	2.98	—1,306	74
Beauty No. 5	2.09	2.98	—1,076	64
Cooper's Special No. 1	2.38	2.21	+ 205	66
Cooper's Special No. 2	5.02	2.21	+3,400	71
Cooper's Special No. 3	5.47	2.21	+3,944	77
Cooper's Special No. 4	6.58	2.21	+5,287	74
Cooper's Special No. 5	2.61	2.21	+ 484	71
Dwarf Champion	2.39	.55	+1,226	53
Dwarf Giant	.58	.55	+ 36	85
Duke of York No. 1	1.36	.71	+ 738	72
Duke of York No. 2	.56	.71	— 181	95
Early Detroit No. 1	1.01	1.35	— 411	74
Early Detroit No. 2	1.35	1.35	.....	67
Fordhook First Early	3.42	1.35	+2,504	49
Gulf State Market No. 1	3.69	2.98	+ 859	69
Gulf State Market No. 2	4.42	2.98	+1,742	73
Gulf State Market No. 3	3.64	2.98	+ 798	69
June Pink No. 1	5.40	.83	+5,529	77
June Pink No. 2	4.83	.83	+4,840	76
June Pink No. 3	4.42	.83	+4,343	78
June Pink No. 4	5.81	.83	+6,025	73
June Pink No. 5	4.92	.83	+4,948	62
Kanora	.84	.71	+ 157	76
Louisiana Red	3.39	.71	+3,242	73
Louisiana Pink No. 1	3.29	2.98	+ 375	72
Louisiana Pink No. 2	3.17	2.98	+ 229	77
Louisiana Pink No. 3	3.91	2.98	+1,125	86
Livingston Globe No. 1	1.34	2.98	—1,984	82
Livingston Globe No. 2	.46	2.98	—3,049	91
Livingston Globe No. 3	.86	2.98	—2,565	78
Livingston Globe No. 4	1.11	2.98	—2,262	24
Livingston Globe No. 5	1.24	2.98	—2,105	66
Longkeeper	2.90	1.35	+1,875	60
Magnus No. 1	.60	1.35	— 907	65
Magnus No. 2	.94	1.35	— 496	57
Marvelosa	3.50	1.35	+2,601	83
Mikado	7.58	.71	+8,312	72
Marglobe No. 1	1.46	.71	+ 907	74
Marglobe No. 2	1.55	.71	+1,016	72
Norton	.16	.71	— 665	95
Perfect First Early	4.59	.55	+4,888	70
Rosy Morn	1.52	1.35	+ 205	73
Self Pruning	4.98	2.21	+3,351	80
Self Topping	4.04	2.21	+2,214	80
Trucker's Favorite No. 1	.53	1.35	— 992	86
Trucker's Favorite No. 2	.47	1.35	—1,064	80

*Check—Livingston's Globe.

During the period from 1924 to 1931, inclusive, a number of strains and varieties of tomatoes were grown on the station, and their performance studied. The yielding capacities of these strains and varieties varied almost as much as did such characters as shape, size, and season of maturity.

Table 8. Annual yield for tomato varieties, 1928.

Variety	Average yield per plant Pounds	Average yield per plant of nearest check* Pounds	Increase (+) or Decrease (—) over Nearest check* Yield per acre Pounds	Marketable fruit Per cent	Early Marketable fruit Per cent
Beauty	1.43	1.98	—1,331	26	84
Burbank	4.58	1.98	+6,292	35	69
Clark's Early	1.74	1.46	+ 677	49	82
Cooper's Special No. 22	.90	1.86	—2,323	41	80
Cooper's Special No. 7	2.43	.92	+3,654	25	79
Cooper's Special No. 8	1.91	1.45	+1,113	34	64
Duke of York	1.39	1.81	—1,016	44	65
Globe No. 21	2.26	1.98	+ 677	33	69
Globe No. 12	1.56	1.92	— 871	27	62
Gulf State Market No. 10	2.15	1.45	+1,694	35	61
Gulf State Market No. 11	2.29	1.45	+2,032	36	87
June Pink No. 15	4.85	2.12	+6,606	40	72
June Pink No. 16	4.90	1.81	+7,477	33	79
Louisiana Pink	3.04	2.12	+2,226	21	69
Marvalosa	3.10	.92	+5,275	34	66
Marglobe No. 2	.57	.61	— 96	28	75
Marglobe No. 3	1.24	.61	+1,524	34	71
Marglobe No. 4	.82	.61	+ 508	43	79
Marglobe No. 5	.77	.92	— 363	49	73
Norton	.88	1.81	—2,250	47	69
Rosy Morn	1.86	2.12	— 629	34	71
Self Topper	2.70	1.45	+3,025	23	76
Viking	2.66	1.86	+1,936	43	95

*Check—Livingston's Globe.

Table 9. Annual yields for tomato varieties, 1928 (Fall Crop)

Variety	Average yield per Plant Pounds	Average yield per plant of nearest check* Pounds	Increase (+) or Decrease (—) over Nearest check* Yield per acre Pounds	Marketable fruit Per cent
Avon Early	8.59	2.97	+13,600	58
Burbank	11.02	2.97	+19,481	30
Cooper's Special	6.61	3.73	+ 6,969	67
Earliana	9.82	2.97	+16,577	51
First Early	8.85	5.32	+ 8,542	42
Gulf State Market	7.22	4.20	+ 7,308	55
Globe	3.28	4.14	— 2,081	67
John Baer	10.71	6.72	+ 9,655	48
Louisiana Pink	9.55	2.97	+15,923	42
Marglobe No. 1	6.72	5.32	+ 3,388	62
Norton	5.51	3.49	+ 4,888	52

*Check—Marglobe (S).

In general, tomatoes of the Earliana type are very prolific. Varieties like Avon Early, Burbank, Winter Queen, and June Pink are of this general type. Fruits of these varieties are flattened, rough or furrowed about the base, meaty, and thin-walled. The vines are rather

Table 10. Annual yields for tomato varieties, 1930.

From pruned and unpruned plants.

Variety	Average yield per plant		Average yield per plant of nearest check*		Increase (+) or Decrease (—) over Nearest check* Yield per acre		Marketable fruit		Early Marketable fruit	
	Pruned Pounds	Unpruned Pounds	Pruned Pounds	Unpruned Pounds	Pruned Pounds	Unpruned Pounds	Pruned Per cent	Unpruned Per cent	Pruned Per cent	Unpruned Per cent
Avon Early	1.97	5.14	2.11	3.30	— 338	+ 4,452	55	53	73	74
Bonny Best	3.25	5.33	2.29	2.66	+2,323	+ 6,461	66	62	70	42
Cooper's Special	4.52	6.03	2.41	2.80	+5,106	+ 7,816	74	66	46	24
Clark's Early	3.91	6.33	2.79	3.04	+2,710	+ 7,961	73	59	71	53
Earliana	3.14	5.66	2.73	2.55	+ 992	+ 7,526	60	50	60	67
First Early	2.96	5.53	2.60	2.85	+ 871	+ 6,485	54	46	71	71
Fargo	2.58	6.86	2.74	2.49	— 387	+10,555	74	75	67	46
Gulf State Market	3.61	4.30	1.94	2.56	+4,041	+ 4,210	80	76	66	55
Globe	2.53	2.07	2.16	2.76	+ 895	— 1,669	82	80	42	21
John Baer	2.93	5.96	2.48	3.18	+1,089	+ 6,727	63	69	71	63
Louisiana Pink	2.16	3.91	2.43	2.81	— 653	+ 2,662	53	60	70	60
Norton	2.45	2.00	2.12	2.77	+ 798	— 1,863	46	54	67	43
Nicholson 498	3.60	6.28	2.99	3.23	+1,476	+ 7,381	60	54	74	75

*Check Marglobe.

weak, open, and may allow the fruits to sunburn. The productivity and earliness of these varieties wins them some favor, but the low grade of the fruit precludes their general use for commercial purposes, as shown in Table 4.

Varieties of the Bonny Best, John Baer, and Clark's Early type have become quite popular in recent years. The yield data presented in Tables 8 and 9 show that these varieties are quite productive, but not so productive as the varieties in the Earliana group. However, the greater uniformity in shape of the fruits of this group makes these varieties more desirable for the commercial producers.

Of the round or globe-shaped tomatoes, Cooper's Special and Self Pruning were the most prolific representatives of this group. Some strains of Globe, Gulf State Market, and Marglobe produced satisfactory yields of very desirable fruit during certain seasons, but, in general, varieties of this type were found to be not nearly as productive as those in the Bonny Best group.

Varieties of the Stone, Greater Baltimore, and Santa Clara Canner type are undesirable, both because of their lateness and because the fruits are quite irregular in shape (Table 11).

The varieties Fargo and Break O' Day deserve special mention because both of these varieties possess many desirable characteristics in common, but are quite unlike in certain other respects. Both varieties belong in the round-shaped, scarlet-fruited class and both are quite early. They are very productive and mature their fruit earlier than do most of the other commercial varieties. The vines of these two varieties are quite small, those of the Fargo variety being real dwarfs. Fruits of the Break O' Day variety averaged larger in size than did those of any of the varieties studied, except Brimmer, while those of the Fargo variety were the smallest tomatoes included in the experiments (Table 11).

On the basis of a single season's experience, the variety Break O' Day offers considerable promise. The large, uniform, globe-shaped fruits of this variety are very attractive, but are thin-walled and do not color up well if harvested too early. The vines are small but very prolific and the fruit matures earlier than most commercial varieties.

Considering the varieties and strains that were observed the greatest number of times, Bonny Best, John Baer, Clark's Early, and similar varieties offer the greatest promise to commercial producers in this region.

Description of the More Important Varieties

Many commercial varieties of tomatoes are desirable in most respects, but so far an ideal variety for the Valley has yet to be found. An ideal variety would be one that produces a large crop of medium-sized fruits, conforming to the globe type, that mature early, and are of an attractive color, hold up well in transit, and do not show objectionable pocketing. The plants should be sufficiently dense to ade-

Table 11. Annual yields for tomato varieties, 1931.

Variety	Number				Average yield per plant marketable fruit Pounds	Average weight marketable fruit Pounds	Acre yields marketable fruit Pounds	Marketable fruit Per cent	Acre yields early marketable fruit Pounds
	Large	Medium	Small	Culls					
Bonny Best (S)	44	317	240	51	5.40	.179	13,068	92	6,337
Bonny Best No. 1	134	310	61	60	6.35	.251	15,367	89	7,403
Bonny Best No. 2	147	367	47	51	7.10	.253	17,182	91	9,801
Bonny Best No. 3	134	375	43	51	6.55	.237	15,851	91	7,463
Bonny Best No. 4	140	257	33	37	5.40	.251	13,068	92	6,829
Bonny Best No. 5	160	406	26	46	7.26	.245	17,569	93	7,539
Bonny Best No. 6	241	372	30	20	7.98	.248	19,311	96	*
Bonny Best No. 7	107	604	78	34	6.52	.165	15,778	96	9,120
Bonny Best No. 8	207	323	24	42	7.57	.273	18,319	93	11,358
Break O' Day (S)	128	365	142	50	6.77	.213	16,383	92	7,479
Cooper's Special (S)	65	286	121	60	4.40	.186	10,648	88	3,789
Clark's Early (S)	45	383	267	61	5.75	.165	13,915	92	8,976
Clark's Early (A)	65	324	102	91	4.88	.198	11,809	84	8,076
Earliana No. 1	293	447	74	46	9.56	.235	23,135	94	*
Earliana No. 3	41	343	132	147	5.09	.197	12,317	77	7,569
Early Detroit No. 1	71	237	19	46	2.67	.163	6,461	87	3,085
Early Detroit No. 2	40	212	60	62	3.44	.220	8,324	83	3,107
Early Detroit No. 3	219	92	39	20	5.08	.287	12,148	91	*
Fargo (S)	17	395	458	42	5.43	.124	13,140	95	15,409
Gulf State Market No. 1	169	275	30	9	5.96	.251	14,423	98	*
Gulf State Market No. 2 (10)	102	406	22	18	9.81	.369	23,740	95	3,237
Gulf State Market No. 3	124	278	38	27	5.40	.245	13,068	94	1,225
Greater Baltimore No. 1	225	263	9	35	6.68	.269	16,165	93	*
Greater Baltimore No. 2	139	223	26	45	2.54	.130	6,146	90	7,139
Greater Baltimore No. 4	50	169	16	23	2.58	.219	6,243	91	2,072
Greater Baltimore No. 6	153	227	21	59	4.99	.248	12,075	87	5,573
Globe No. 1 (10)	94	414	106	52	6.90	.224	16,698	90	3,872
Globe No. 2	97	506	431	48	8.98	.173	21,731	95	3,078
Globe No. 3	101	274	109	16	5.12	.211	12,390	96	*
Globe No. 4	72	289	104	80	4.89	.210	11,833	85	2,147
Globe No. 6	88	314	120	110	5.60	.214	13,552	82	665
Indiana Baltimore No. 1	72	233	12	65	3.83	.241	9,268	83	2,405
John Baer (S)	18	322	201	25	4.69	.173	11,349	95	5,090
June Pink (S)	19	325	212	48	5.19	.168	12,559	81	8,380
Kilgore Special (K)	21	390	251	62	5.38	.162	13,019	91	4,083
Marglobe No. 1 (10)	96	192	30	22	3.72	.249	8,902	93	1,028
Marglobe No. 2	64	171	31	20	2.99	.224	7,235	93	2,147
Marglobe No. 3	74	304	61	31	5.55	.255	13,431	93	5,989
Marglobe No. 4	182	154	16	4	5.71	.208	11,398	98	*

Marglobe No. 5	89	152	21	36	4.30	.328	10,406	88	3,811
Marglobe No. 6	93	130	29	25	3.40	.269	8,228	90	1,050
Marglobe (K)	70	191	57	20	3.55	.223	8,591	94	3,846
Marglobe (S)	107	183	37	17	4.23	.258	10,236	95	3,600
Master Marglobe (S)	69	277	71	22	4.84	.232	11,712	95	6,596
Sunrise (R)	123	292	92	72	5.81	.229	14,060	89	6,534
Santa Clara Canner No. 4	106	28	.....	24	2.62	.391	6,340	84	*
Stone No. 1	50	65	8	26	1.63	.265	3,944	82	151
Stone No. 2	118	98	58	60	3.88	.283	9,389	87	1,543
Stone No. 3	41	99	20	22	1.85	.231	4,447	87	332
Stone No. 4	147	167	67	95	4.43	.232	10,720	80	.....
Stone No. 6	39	93	61	16	1.47	.152	3,557	92	302

*Early fruit used for descriptive work.

quately protect the fruit, without undue shading, and should be resistant to root and foliage diseases.

Marglobe: Marglobe is a variety of rather recent introduction that has been quite popular because of its resistance to certain root and foliage diseases, and because of the desirable qualities of its fruit. However, the shape of the fruit is not particularly uniform, and a large percentage of the fruits are pocketed. On light, sandy loam soils, it appears to be somewhat unproductive and matures its fruit relatively late. Marglobe vines are very dense, delaying maturity of the fruit by shading.

Bonny Best, John Baer, Clark's Early: Growers who do not care to grow Marglobe on account of its unproductiveness and lateness have found tomatoes of the Bonny Best type desirable. The fuit is not as uniform as it should be, and some of the fruits show objectionable pocketing. Vines of this group are medium dense and adequately protect the fruit without undue shading, but are not disease-resistant.

Cooper's Special, Self Pruning: Fruits of this variety are fairly regular in regard to shape, but are quite variable in size. The fruits are round or globular and show considerable angularity due to pocketing. The vines are quite prolific and mature their fruit at about the same time as Bonny Best. Vines are of a determinate habit of growth, with short internodes.

Gulf State Market: This is a purple-fruited sort of the globe type. The vines are quite prolific, but the fruit is not as uniform in regard to size or shape as is that of Globe. The vines are quite vigorous and dense but are not resistant to disease. A large percentage of the fruits are pocketed. Season of ripening is about the same as Globe.

Globe: This variety was at one time the most popular variety with Valley growers. The fruits are pomegranate-purple in color, of the true globe shape, and quite uniform. The average size of the fruit is about 3 ounces. The vines are rather unproductive some seasons and are not disease-resistant. Their foliage is quite dense and may interfere with the maturity of the crop under certain climatic conditions. Many of the fruits show angularity from pocketing, and ripen late in the season.

June Pink: June Pink is an early pink-fruited tomato of the Earliana type. The fruits are meaty, quite variable in shape, rather thin-skinned, and are seldom pocketed. The vines are not as large as the average and rather open, thus allowing a portion of the fruit to sunburn. It is not a disease-resistant variety.

Louisiana Pink: This is a midseason, purple-fruited, disease-resistant variety that produces oblate fruit of rather variable shape. A large percentage of the fruits show angularity due to pocketing. The vines

are very dense and may cause shading of the fruit. The vines are very productive.

Norton: Norton is a late-maturing, scarlet-fruited sort that is disease-resistant and that has very large, dense vines. It is of interest because of its extraordinary unfruitfulness. Many vines produce no marketable fruit and some vines produce very few fruits of any kind.

Fargo: Vines of this variety are very small and rather open. It is more prolific than any variety that has been observed, and matures its crop ten days earlier than its nearest competitor. It produces fruit that is fairly uniform in regard to size and shape, but which is too small to be commercially desirable. Few of the fruits show undesirable pocketing. This variety is of interest because it possesses practically all of the desirable characters, with the exception of size of fruit.

Break O' Day: This new variety attracted considerable attention on its initial appearance. Its performance at the station during the season of 1931 indicates that it is a variety of promise. It is one of the earliest varieties and produces an abundant crop of large, oblate fruits that show slightly more yellow than is desirable. The thinness of the fruit wall causes the fruit to show rather marked angularity. The percentage of pocketed fruit was no greater than in the case of varieties like Bonny Best, Marglobe, or Stone. The vines are rather small and rather open, objectionable features which may be largely overcome by the use of fertilizer.

PRUNING

As shown in Table 10, pruning tends to lower the total yields of fruit but increases the average size of the fruit and hastens the maturity of the crop in most instances. Some of the more vegetative types like Norton and Globe are more prolific when pruned, while non-vegetative types like Earliana and Fargo react unfavorably to the pruning treatment. Where earliness is a factor of importance, it seems that pruning the vines to two or three main branches would be advantageous.

SPACING

On the basis of a single season's work (Table 12), it may be said that spacing has considerable influence on the performance of the tomato plant. The space allowed the plants in the rows and the distance between the rows of plants both affect production. Under the conditions of this test, the closely-spaced plants (3′ x 3′) produced the greatest acre yield of fruit and the fruit was not materially smaller than that from vines spaced 6′ x 6′. It should also be noted that the plats where the vines were spaced 3′ x 3′ produced more early and midseason fruit than did those spaced 3′ x 6′ or 6′ x 6′.

Table 12. Effect of spacing on date of maturity, yield, and average size of fruit*.

Spacing	Acre yields by dates			Acre yields Pounds	Mean Weight of fruit
	5.23 Pounds	6.8 Pounds	6.22 Pounds		
3 x 3	464	11,068	7,581	19,114	0.17
3 x 6	166	7,577	4,930	12,674	0.19
6 x 6	55	2,062	3,918	6,036	0.20

*Cooper's Special plants used in this test.

It is not definitely known just why the closer spacing gave the greatest yields, but it should be pointed out that close-planted vines protect each other from the wind, and do not make the excessive vegetative development shown by plants which are allowed ample space for development. The variety used in this test was Cooper's Special.

FERTILIZER EXPERIMENTS WITH TOMATOES

The use of commercial fertilizers in the production of tomatoes in the Lower Rio Grande Valley has been a subject of considerable interest to growers, especially during the past few years. The rather variable results secured from fertilizers have left some growers with a doubt in their mind as to the profitable use of these materials. Potash has been specified as an important ingredient of the fertilizer mixture by some packers and shippers. This recommendation is based on the assumption that fertilizers containing potash materially improve the shipping quality of the fruit produced by vines fertilized with this material.

Unfavorable weather, especially rain, during the harvesting period, has probably done more to discourage growers in the use of fertilizers than any one factor. The use of non-prolific varieties of tomatoes has also caused growers to fail to realize the full benefit from fertilizer applications.

Plan of Experiments

The experiments concerning the use of fertilizers in the production of tomatoes were conducted in much the same manner as were the variety tests previously discussed. The fertilizer plats consisted of four rows six feet apart and 132 feet long. The two outside rows were used as buffer rows and yields from these rows were not recorded. The plats were laid out on two standard acres, 132 ft. by 330 ft. in size. This made it possible to practice a two-year rotation with other field or vegetable crops.

The soil on which these tests were conducted is Victoria Clay Loam and is quite flat. It is typical of a large tomato-producing area in the Lower Rio Grande Valley (6, 7, 8) and is better adapted to tomato production than is the Victoria Sandy Loam on which the variety tests

were conducted. Yields were taken on a plat basis, weight of both total amount of fruit and the amount of marketable fruit being made to the nearest ounce. A double-beam, counter scale was used in making the weighings. The percentage of fruits showing "pockets" was determined either by counting or weighing the cut fruits. The prevalence of virus diseases in the experimental planting made it seem advisable to select representative plants and record yields on the basis of average plant yields. The same number of plants from areas of perfect stand were selected within each fertilizer plat.

It has been pointed out by Kraus and Kraybill (4) that it is not the total quantity of nutrients present in the plant which is operative in the fruiting response, but rather the balance between the various essential nutrients. The fertilizer applications reported in Tables 13 to 22 were made in an attempt to adjust the balance in the tomato plants as affected by varying the nitrogen, phosphoric acid, and potash additions to the soil. The results should give some idea concerning the most profitable kind or grade of fertilizer to use on the particular kind of soil on which these tests were conducted.

After two years' experience, it became obvious that vegetative varieties like Globe were not as responsive to fertilizers as were more productive varieties of the Cooper's Special type. This last named variety was used in the fertilizer experiments during the period from 1927 to 1930, inclusive. Break O' Day, a very prolific, non-vegetative type, was used during the 1931 season.

Recording the yield data on a hill or plant basis has brought out the fact that there is a marked variation in both the quantity and quality of the crop produced from individual plants of the same variety grown under similar conditions.

Preliminary Experiments in 1925

During the first season a preliminary experiment with fertilizers was conducted to determine the response of the tomato plant to some of the more common fertilizer materials and mixtures then in rather general use in the older tomato-producing areas. The schedule of applications was in general based on the work of the Troup Station (3). The results of this preliminary test are summarized in Table 13. It will be noted that fertilizer application on Plat 16 gave a most decided increase over the check or unfertilized plats nearest it. This fertilizer application gave results that were superior to those secured from a 500-pound application of 4.5-7-7 fertilizer. Cottonseed meal and superphosphate, even in double the amounts applied on Plat 16, failed to give results comparable to those secured where iron sulphate was included in the mixture. In the two instances where the rate of application was doubled, the results secured were not as satisfactory as with the lighter application. An application of 20 tons of manure per acre for this one season gave results second only to those secured by the

use of the mixture of cottonseed meal, superphosphate, and iron sulphate.

Table 13. Tomato fertilizer experiments, 1925.

Plat	Fertilizer treatment	Amount per acre	Average yield per plant Pounds	Average yield per plant of Nearest check* Pounds	Increase (+) or Decrease (—) over Nearest check* Yield per acre Pounds
2	Manure	25 tons	2.82	2.55	+1,306
4	Muriate of Potash	125 lbs.	2.90	3.10	— 968
6	Superphosphate	250 lbs.	2.83	2.59	+1,161
8	Superphosphate	500 lbs.	1.94	2.67	—3,533
10	Nitrate of Soda	250 lbs.	3.17	2.93	+1,161
12	7-4 5-7 P-N-K	500 lbs.	4.26	4.12	+ 677
14	Cottonseed meal Superphosphate	250 lbs. 250 lbs.	4.36	4.43	— 338
16	Cottonseed meal Superphosphate Iron Sulphate	250 lbs. 250 lbs. 50 lbs.	3.75	3.15	+2,904
18	Cottonseed meal Superphosphate	500 lbs. 500 lbs.	2.34	2.72	—1,839

*Check plats received no fertilizer treatment.

Results of Fertilizer Experiments 1926

The experiments with fertilizer in 1926 are reported separately for the reason that a change in the schedule of applications was made after this season. The results obtained must be considered as a single season's experience. It is interesting to note that cottonseed meal and superphosphate mixture gave the greatest increase in yield this season, followed by the application of complete fertilizer, 4.5-7-7 (N. P. K.). Manure alone, at the rate of 20 tons per acre, gave the third best increase in yield (Table 14).

Table 14. Tomato fertilizer experiments, 1926.

Plat	Fertilizer treatment	Amount per acre	Average yield per plant Pounds	Average yield per plant of Nearest check* Pounds	Increase (+) or Decrease (—) over Nearest Check* Yield per acre Pounds
2	Manure	10 tons	2.22	2.05	+187
3	Sulphate of ammonia	50 lbs.	1.43	2.05	—682
4	Sulphate of ammonia Superphosphate	50 lbs. 300 lbs.	1.35	1.79	—484
5	Superphosphate Muriate of potash	300 lbs. 60 lbs.	1.71	1.54	+187
6	Superphosphate	300 bls.	1.41	1.54	—143
8	Sulphate of ammonia Muriate of potash	50 lbs. 60 lbs.	1.56	1.54	+ 22
9	Kainit	250 lbs.	1.11	1.54	—473
10	Cottonseed meal Superphosphate	150 lbs. 300 lbs.	1.58	1.29	+319
11	Sulphate of ammonia Superphosphate Sulphate of potash	85 lbs. 300 lbs. 52 lbs.	1.27	1.04	+253
12	Sulphate of ammonia Superphosphate Muriate of potash	85 lbs. 300 lbs. 52 lbs.	1.06	1.04	+ 22
13	Sulphate of ammonia Cottonseed meal Superphosphate Muriate of potash	25 lbs. 100 lbs. 300 lbs. 60 lbs.	1.04	1.04	.....

*Check plats received no fertilizer treatment.

Fertilizer Experiments 1927 to 1931

During the period from 1927 to 1931, inclusive, a uniform schedule of application was followed. In these experiments 600 pounds per acre of a 4-8-4 fertilizer was used as a basis for comparison. The proportion of potash in the formula was varied from 4 per cent to 8 per cent, as shown in the tables. Superphosphate and manure were used alone. In one case the amount of 4-8-8 fertilizer applied was doubled so that the plat received an application equivalent to 1,200 pounds per acre. The sources of mineral nutrients were nitrate of soda, superphosphate, and muriate of potash. The fertilizer materials were applied to the soil about the plants at the time of the final thinning. This method of distribution made it possible to eliminate much of the washing of fertility to the lower ends of the rows by irrigation water.

The results of these experiments are summarized in Tables 15 to 22, inclusive. It should be noted that the largest increases in yields were secured by the use of fertilizer during the 1928 and 1931 seasons. Increases were consistent but not particularly large during the season of 1927. The presence of virus diseases in the planting in 1929 and the presence of unusual numbers of insects in 1930 reduce the value of these data for drawing conclusions. It is this element of uncontrollable factors in production that causes the farmer to be undecided as to the benefits to be derived from fertilizing a crop of tomatoes.

It will be seen that the 600-pound application of 4-8-4 fertilizer per acre gave rather consistent yield responses each season, except during 1929. When potash was omitted from the formula (4-8-0), the yield responses were superior to those secured with the 4-8-4 fertilizer. Doubling the percentage of potash in the formula did not materially affect the yield of fruit, but did affect the size of the fruit (Table 21). Superphosphate applied alone was approximately half as effective in increasing yields as was the 4-8-0 mixture. Manure applied at the rate of 20 tons per acre gave consistently high increases in yield throughout the period covered by this experiment. The application of 4-8-8 fertilizer, at the rate of 1,200 pounds per acre, gave increases over the five-year period, amounting to 1,300 pounds of fruit per acre per season. The increases from manure were 700 pounds per acre per season in excess of this figure (Table 20). The results of these experiments, especially in regard to the use of superphosphate, seem to be borne out by the experience of commercial producers of tomatoes in this region during the last few years.

Effect of Fertilizer Treatment on Size of Fruit

As shown in Table 21, manure and 1,200 pounds per acre of 4-8-8 fertilizer produced the largest fruits during the five-year period covered by these tests. The average weight of the fruit from the manured plats was 0.277 pounds compared with 0.274 for the 4-8-8 fertilizer plats and 0.259 pounds for the plats which received superphosphate

Table 15. Tomato fertilizer experiments, 1927.

Plat	Fertilizer treatment	Amount per acre	Average weight marketable fruit Pounds	Average yield per plant marketable fruit Pounds	Acre yields marketable fruit Pounds	Increase (+) or Decrease (—) over Nearest check* Yield per acre Pounds	Marketable fruit Per cent
1	Check	.....	.29	.91	1,101	.....	79
2	Manure	20 tons	.24	2.87	3,472	+2,371	63
3	4–8–4	600 lbs.	.22	2.36	2,855	+1,754	67
4	4–8–0	600 lbs.	.19	1.98	2,395	+1,294	57
5	Manure	20 tons	.25	2.10	2,541	+ 895	68
6	0–16–0	600 lbs.	.24	1.99	2,407	+ 762	58
7	Check	.....	.24	1.36	1,645	.....	75
8	4–8–8	600 lbs.	.24	2.09	2,528	+ 883	71
9	4–8–0**	600 lbs.	.24	1.76	2,129	+ 484	75
10	4–8–8	600 lbs.	.28	1.82	2,202	+ 556	77
11	4–8–4	600 lbs.	.27	2.03	2,456	+ 810	81
12	0–16–0	600 lbs.	.23	1.25	1,512	+ 520	72
13	4–8–8	1,200 lbs.	.27	1.84	2,226	+1,234	81
14	Check	.....	.27	.82	992	.....	70

*Check plats received no fertilizer treatment. **250 pounds Kainit per acre applied to this plat in 1926.

Table 16. Tomato fertilizer experiments, 1928.

Plat	Fertilizer treatment	Amount per acre	Average weight marketable fruit Pounds	Average yield per plant marketable fruit Pounds	Acre yields marketable fruit Pounds	Increase (+) or Decrease (—) over Nearest check* Yield per acre Pounds	Marketable fruit Per cent
1	Check	.....	.28	2.17	5,251	.....	46
2	Manure	20 tons	.31	4.21	10,188	+ 4,936	58
3	4–8–8	600 lbs.	.32	2.45	5,929	+ 677	51
4	4–8–0	600 lbs.	.33	2.77	6,703	+ 1,452	51
5	Manure	20 tons	.31	7.10	17,182	+ 9,026	47
6	0–16–0	600 lbs.	.32	7.87	19,045	+10,890	58
7	Check	.....	.27	3.37	8,155	.....	56
8	4–8–8	600 lbs.	.30	4.46	10,793	+ 2,637	59
9	4–8–0**	600 lbs.	.30	4.41	10,672	+ 2,516	55
10	4–8–8	600 lbs.	.28	2.17	5,251	— 2,904	55
11	4–8–4	600 lbs.	.28	1.87	4,525	— 3,630	48
12	0–16–0	600 lbs.	.28	4.22	10,212	— 2,516	53
13	4–8–8	1,200 lbs.	.30	5.33	12,898	+ 169	74
14	Check	.....	.19	5.26	12,729	.....	59

*Check plats received no fertilizer treatment. **250 pounds Kainit per acre applied to this plat in 1926.

Plat	Fertilizer treatment	Amount per acre	Average weight marketable fruit Pounds	Average yield per plant marketable fruit Pounds	Acre yields marketable fruit Pounds	Increase (+) or Decrease (—) over Nearest check* Yield per acre Pounds	Marketable fruit Per cent
1	Check	.....	.22	3.01	7,284	.....	70
2	Manure	20 tons	.20	1.34	3,242	—4,041	46
3	4–8–4	600 lbs.	.20	3.25	7,865	+ 680	69
4	4–8–0	600 lbs.	.22	2.87	6,945	— 338	68
5	Manure	20 tons	.21	3.35	8,107	+1,331	67
6	0–16–0	600 lbs.	.21	2.54	6,146	— 629	56
7	Check	.....	.20	2.80	6,776	.....	64
8	4–8–8	600 lbs.	.21	3.45	8,300	+1,524	65
9	4–8–0**	600 lbs.	.22	4.03	9,752	+2,986	71
10	4–8–8	600 lbs.	.19	3.03	7,332	+ 556	81
11	4–8–4	600 lbs.	.21	1.96	4,743	—1,475	59
12	0–16–0	600 lbs.	.20	2.64	6,388	+ 169	66
13	4–8–8	1,200 lbs.	.20	2.31	5,590	— 729	70
14	Check	.....	.21	2.57	6,219	.....	77

*Check plats received no fertilizer treatment. **250 pounds of Kainit per acre applied to this plat in 1926.

Table 18. Tomato fertilizer experiments, 1930.

Plat	Fertilizer treatment	Amount per acre	Average weight marketable fruit Pounds	Average yield per plant marketable fruit Pounds	Acre yields marketable fruit Pounds	Increase (+) or Decrease (—) over Nearest check* Yield per acre Pounds	Marketable fruit Per cent
1	Check	.....	.18	1.35	3,267	.....	83
2	Manure	20 tons	.18	1.05	2,541	— 726	85
3	4–8–4	600 lbs.	.18	.83	2,008	—1,258	77
4	4–8–0	600 lbs.	.16	1.10	2,662	— 605	82
5	Manure	20 tons	.14	1.10	2,662	+ 629	75
6	0–16–0	600 lbs.	.15	.62	1,500	— 532	71
7	Check	.....	.16	.84	2,032	.....	69
8	4–8–8	600 lbs.	.14	1.17	2,831	+ 798	75
9	4–8–0**	600 lbs.	.12	.67	1,621	— 411	82
10	4–8–8	600 lbs.	.13	.76	1,839	— 193	83
11	4–8–4	600 lbs.	.13	1.07	2,589	— 258	70
12	0–16–0	600 lbs.	.16	1.38	3,339	— 508	73
13	4–8–8	1,200 lbs.	.16	1.17	2,831	—1,016	68
14	Check	.....	.18	1.59	3,847	.....	61

*Check plats received no fertilizer treatment. **250 pounds of Kainit per acre applied to this plat in 1926.

Table 19. Tomato fertilizer experiments, 1931.

Plat	Fertilizer treatment	Amount per acre	Average weight marketable fruit Pounds	Average yield per plant marketable fruit Pounds	Acre yields marketable fruit Pounds	Increase (+) or Decrease (—) over Nearest check* Yield per acre Pounds	Marketable fruit Per cent
1	Check	.....	.45	2.60	6,292	.....	89
2	Manure	20 tons	.43	3.52	8,518	+2,226	85
3	4–8–4	600 lbs.	.41	4.62	11,180	+4,888	88
4	4–8–0	600 lbs.	.38	5.33	12,898	+6,606	92
5	Manure	20 tons	.50	4.75	11,495	+3,412	90
6	0–16–0	600 lbs.	.49	2.57	6,219	—1,863	83
7	Check	.....	.43	3.34	8,082	.....	92
8	4–8–8	600 lbs.	.44	2.98	7,211	— 871	86
9	4–8–0**	600 lbs.	.46	3.48	8,421	+ 338	79
10	4–8–8	600 lbs.	.50	2.58	6,243	—1,839	72
11	4–8–4	600 lbs.	.43	3.15	7,623	— 72	81
12	0–16–0	600 lbs.	.31	2.75	6,602	—1,089	66
13	4–8–8	1,200 lbs.	.44	6.13	14,834	+7,139	85
14	Check	.....	.40	3.18	7,695	.....	75

*Check plats received no fertilizer treatment. **250 pounds of Kainit per acre applied to this plat in 1926.

Table 20. Tomato fertilizer experiments, 1927-1931.

Summary.

Mean increase (+) or decrease (—) over nearest check, yield per acre of marketable fruit.

Plat Nos.	Treatment	1927 Pounds	1928 Pounds	1929 Pounds	1930 Pounds	1931 Pounds	5 Year Mean
2 and 5	Manure (20 T.)	+1,633	+6,981	—1,355	— 48	+2,819	+2,006
3 and 11	4–8–4 (600 lbs.)	+1,282	—1,476	— 397	— 758	+2,407	+ 211
4 and 9	4–8–0 (600 lbs.)	+ 889	+1,984	—1,323	— 508	+3,472	+ 902
6 and 12	0–16–0 (600 lbs.)	+ 641	+4,186	— 229	— 520	—1,476	+ 520
8 and 10	4–8–8 (600 lbs.)	+ 719	— 133	+1,040	+ 302	—1,355	+ 114
13	4–8–8 (1200 lbs.)	+1,234	+ 169	— 729	—1,016	+7,139	+1,359

Table 21. Effect of fertilizer treatment on average weight of marketable fruit

Summary

Plat Nos.	Treatment	Amount per acre	1927 Pounds	1928 Pounds	1929 Pounds	1930 Pounds	1931 Pounds	Five year Mean
2	.....	.....	.24	.31	.20	.18	.43	.....
5	Manure.....	20 tons	.25	.31	.21	.14	.50	.277
3	.....	.....	.22	.32	.20	.18	.41	.....
11	4–8–4.....	600 lbs.	.27	.28	.21	.13	.43	.265
4	.....	.....	.19	.33	.22	.16	.38	.....
9	4–8–0.....	600 lbs.	.24	.30	.22	.12	.46	.262
6	.....	.....	.24	.32	.21	.15	.49	.....
12	0–16–0.....	600 lbs.	.23	.28	.20	.16	.31	.259
8	.....	.....	.24	.30	.21	.14	.44	.....
10	4–8–8.....	600 lbs.	.28	.28	.19	.13	.50	.271
13	4–8–8.....	1,200 lbs.	.27	.30	.20	.16	.44	.274
1	.....	.....	.29	.28	.22	.18	.45	.....
7	Check.....	None	.24	.27	.20	.16	.43	.264
14	.....	.....	.27	.19	.21	.18	.40	.....

Table 22. Effect of fertilizers on pocketing

Plat No.	Fertilizer treatment	Percent of fruits affected with "Tomato Pockets."						Increase or decrease over nearest check.					
		1926*	1927*	1928*	1929*	1931**	Mean	1926	1927	1928	1929	1931	Mean
1 & 7	Check Untreated	56	11	32	61	15	35						
3	4–8–4	36	10	42	72	9	34	—20	— 1	—10	+11	— 6	— 1
7 & 14	Check	68	16	32	68	18	40						
11	4–8–4	72	9	23	80	19	40	+ 4	— 7	— 9	+12	+ 1	.....
7 & 14	Check	68	16	32	68	18	40						
8	4–8–8	84	10	25	68	27	43	+16	— 6	— 7	.....	+ 9	+ 3
7 & 14	Check	68	16	32	68	18	40						
10	4–8–8	60	13	27	69	24	39	— 8	— 3	— 5	+ 1	+ 6	— 1
7 & 14	Check	68	16	32	68	18	40						
13	4–8–8	68	9	24	67	15	37	.....	— 7	— 8	— 1	— 3	— 3
1 & 7	Check	56	11	32	61	15	35						
4	4–8–0	56	14	19	74	17	36	.....	+ 3	—13	+13	+ 2	+ 1
1 & 7	Check	56	11	32	61	15	35						
6	0–8–0	76	28	30	68	19	44	+20	+17	— 2	+ 7	+ 4	+ 9
7 & 14	Check	68	16	32	68	18	40						
12	0–8–0	60	10	30	52	16	34	— 8	— 6	— 2	—15	— 2	— 6
1 & 7	Check	56	11	32	61	15	35						
2	Manure	48	34	25	79	18	40	— 8	—23	— 7	+18	+ 3	+ 5
1 & 7	Check	56	11	32	61	15	35						
5	Manure	42	13	25	73	13	33	—14	— 2	— 7	+12	— 2	— 2

*Based on weight of "Pocketed" fruit
**Based on number of "Pocketed" fruit
Plat No. 9 was discarded in 1927 on account of the application of 250 lbs. of Kainit in 1926
Varieties used: Globe 1925-27; Cooper's Special 1927-29; Break O' Day 1931

only. The fruit from the superphosphate plats was slightly smaller than that from the unfertilized plats.

Effect of Fertilizer Treatment on Pocketing

The data in regard to the amount of pocketed fruit produced on the different plats are summarized in Table 22. The six seasons' results presented in this table do not warrant the conclusion that fertilizer treatments affect the amount and degree of pocketing (puffing) under the conditions of these experiments. It should be noted that there is no consistency in the results as indicated by percentage of pocketed fruit from the different plats. It was observed that there was marked variation in the amount of pocketed fruit produced by plants of the same variety grown under the same conditions as regards fertilizer treatment, irrigation, cultivation, etc. The percentage of pocketing varied from zero up to 85 per cent in the case of some plants observed.

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Seed for the variety test in 1931 (Table 11) was furnished by the office of Horticultural Crops and Diseases, U. S. Department of Agriculture.

SUMMARY

1. Bonny Best, John Baer, Clark's Early, and similar varieties proved to be the most suitable types for commercial planting in the Lower Rio Grande Valley.

2. Varieties of the Earliana type were early and prolific, but a large percentage of the fruit was unmarketable, because of its undesirable shape and poor shipping quality.

3. Marglobe, Globe, Gulf State Market, and similar varieties were late and somewhat unprolific, but produced fruit of desirable shape and good shipping quality.

4. Varieties like Stone, Norton, and Santa Clara were too late to be commercially desirable.

5. Fargo proved to be a very early, prolific variety, but the fruit was under size.

6. Break O' Day made a very favorable showing during the single season it was included in the tests.

7. Varieties of the Earliana type produced less "pocketed" fruit than did varieties of the Globe type.

8. Pruning reduced total yields in most instances, but increased the percentage of early, marketable fruit.

9. Pruning increased the total yield of marketable fruit in the case of varieties like Globe, Marglobe, and Norton.

10. Close spacing of the plants increased the yield of early, marketable fruit and did not materially affect the size of the fruit.

11. Manure applied at the rate of 20 tons per acre gave the largest, most consistent increases in yield.

12. Applications of 1,200 pounds per acre of 4-8-8 fertilizer gave yields amounting to 60.5 per cent of those secured with manure.

13. Applications of 600 pounds per acre of 4-8-8 and 4-8-4 fertilizer gave yields lower than those secured with 600 pounds per acre of superphosphate or 4-8-0 fertilizer.

14. Superphosphate applied at the rate of 600 pounds per acre gave yields approximately 75 per cent less than those secured with 20 tons of manure and 61 per cent less than those secured with 1,200 pounds of 4-8-8 fertilizer.

15. The two fertilizer treatments which gave the largest increases in yield also produced the largest fruit, but the differences were small.

16. "Pocketing" was not materially affected by the use of fertilizer but caused slightly less loss in the case of the plats receiving superphosphate at the rate of 600 pounds per acre.

17. "Pocketing" was confined to a few individual plants in many instances, and caused more loss in some seasons than in others.

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