

A Study of the Cucumber Industry at Terre Haute, Indiana

ROBERT RUDD, Indiana State Teachers College

The largest greenhouse in the world with one central heating plant is located at Terre Haute, Indiana. Davis Gardens, as it is known to the local populace, started from two one-acre greenhouses in 1914 and today has 35 acres under glass with an actual growing area of 1,020,000 square feet. The difference between this figure and the former one is due largely to the fact the greenhouse proprietor counts the sides, ends, and roofs of the buildings in totalling acreage under glass. Of the total growing area, 33 acres are used for growing cucumbers, while the remaining two acres are used for the production of tomatoes. The latter crop is grown on an experimental-commercial basis. Experiments are being carried on with various types of cultures, hydroponics mainly. At the same time, production is maintained at a commercial rate. During the height of the growing season approximately 2500 pounds are picked daily. Cucumbers are grown entirely on a commercial scale. From the 15th of December until about August 10th an average of 2000 dozen fruits are picked daily. This industry has grown to such proportions that it is a major source of hothouse cucumbers for the great vegetable distributing warehouses in Boston, Cleveland, Detroit, Chicago, and other main distribution points in eastern United States.

Location

A considerable amount of geography was employed in the original selection of the site for this unique but definitely successful enterprise. Many factors must be considered in locating a greenhouse. First of all, the latitude should be such that the greenhouse can produce for a considerable period of time before and after field production is possible in that locality. Location should be far enough north so that the normal growing season is relatively restricted; yet care must be taken not to locate so far north that excessive costs on items such as fuel will materialize.

An extremely important factor is that of markets. Not only should a good market be available in the immediate vicinity, but access to other markets through suitable transportation facilities is important. Originally most of the shipping of the product was done by rail, consequently access to several large railroad systems was necessary. Four large railroads have routes through Terre Haute making it a good location for that reason. The New York Central, Pennsylvania, Chicago and Eastern Illinois, and Chicago, Milwaukee, and St. Paul railroads have a combined coverage of considerable market area. Emphasis later shifted to shipping by truck, and today the majority of Davis Gardens produce is carried by a truck fleet. The "crossroads of the nation,"

U. S. 40 and U. S. 41 pass through Terre Haute and add to its desirability as a shipping center.

In choosing a greenhouse location, a nearby source of suitable fuel is essential. At the time Davis Gardens was established the bituminous

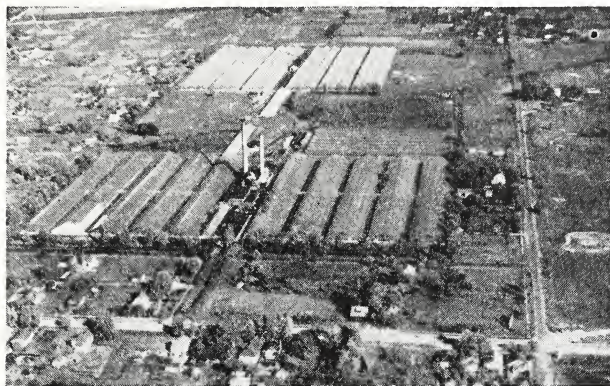


Fig. 1. Aerial view of Davis Gardens.

coal of the Indiana coal fields seemed an excellent source of supply. When the average tonnage used per year is realized, the desirability of a very close source is apparent. An average of 20,000 tons are burned annually. Freight costs from the Mount Pleasant Mine four miles from Davis Gardens and from the Blackhawk Mine ten miles away are not nearly the factor they would have been in a less suitable location. A major fuel-saving item is sunlight. The importance of sunlight may be more thoroughly realized when the fact is considered that on a sunny day, even though the air outside has a temperature near 0°F ., the heat may be turned off entirely for the several hours that the sun's rays are most direct. Water vapour in the enclosed air of the greenhouse condense on the glass readily; and, after running into cracks around the glass plates, it freezes on contact with the air and effectively seals the leaks. Other conditions, a calm day for example, are necessary for such fuel saving opportunities; but sunlight is the major factor. In considering this point Weather Bureau records over a considerable number of years were consulted for the percent of possible sunshine during the so-called "dark months." Figures from the U. S. Weather Bureau Bulletin list 42% of possible sunshine for December, 45% for January, 48% for February, and 53% for March in Terre Haute. Mean normal temperatures are important also, of course, in fuel consideration. From the same publication the figure for Terre Haute in December is 32.5°F ., January is 28.7° , February is 31.3° , and March is 40.6° . No one particular item of location is sufficient; many must be considered before a decision is made. Certainly in this instance many major items combined to make the present location desirable. Other factors (source of fertilizers, labor supply, type of

labor) will be referred to that perhaps are not major ones; still their combined effect is one of aiding rather than deterring.

Heating

Mention was made earlier that Davis is the largest greenhouse in the world with one central heating plant. Other greenhouses have larger area under glass but heating is accomplished through several small heating plants. At Davis Gardens the heating plant consists of four boilers, two with a 500 horsepower rating each and two with a 600 horsepower rating. When the plant was built, stoker size coal was considerably cheaper than ordinary lump. Since the advent of the home stoker relative prices of stoker coal and lump coal have changed; and it may soon be cheaper for Davis to install a crusher so that lump coal, some of which is cheaper, can be used. Fueling is accomplished by Babcock and Wilcox chain grate stokers. A low pressure steam heat system is in use and steam at 125 pounds per square inch is conveyed from the heating plant to distribution points from whence it is further distributed into the various greenhouses. This particular pressure is used since it provides approximately as dry a steam as is feasible. The longest push is one of 1000 feet to one of the distributing points in a 12 inch pipe, or header. Inside the greenhouse the steam enters in low pressure headers, and is conveyed into a series of coils, some along the sides, others near the roof and in the center of the building. Temperatures in the greenhouse are regulated very carefully to secure optimum growing conditions. A night temperature of 66°F. is maintained which varies from the day temperature. Even day temperatures vary according to whether the day is cloudy or sunny. It is of interest to note that on sunny days a temperature of 85°F. is maintained. On cloudy days the temperature is held at 75°F. since less photosynthesis occurs, and higher temperatures cause the vines to stretch. The greatest foe of even temperature maintenance is a cold, windy day. Rapid movement of cold air about the greenhouse buildings constantly robs the area of heat. In a 24 hour period on such a day 250 tons of coal may be consumed. In contrast 100 tons are burned on a calm day with the same outdoor temperature.

Cucumber Culture

Producing cucumbers at a rate of 2000 dozen a day is something that requires considerable planning and careful methods. From the seed to the final product, established practices are maintained in the care and growing of the cucumber plant. Many of the procedures have originated in the experimental plots at Davis Gardens. The cucumber seed is sown about October 15th in a specially prepared seed bed made of compost soil and sand. This growing medium is not as rich as the soil into which the seedlings will be later transplanted. Sowings are staggered, about 20,000 a day being an average sowing, so that too many of the seedlings will not require transference into the pots at the

same time. On the third day following the sowing, most of the first group of plants have attained the inch and one-half height required for potting. The plants are maintained in a special propagating house from the time of sowing until two weeks after potting. The seedlings are then planted in the area where they are to bear fruit. Use of a central propagating house for sowing and care of the young seedlings eliminates the problem of very careful temperature regulation throughout the entire greenhouse area as well as cutting fuel costs. During the two weeks potting period careful check is kept on the seedlings, and those which fail to show satisfactory progress are eliminated. This measure insures a majority of top quality plants and makes unnecessary constant replacement of plants that fail at various intervals after final planting. The growing soil used is a sandy loam with fairly high humus content. During the growing season of a crop, approximately 200 tons of manure are used per acre. When total acreage is considered it is realized that location not too far from a source of fertilizer is desirable. The Chicago stockyards, an ample source, are not too far from Terre Haute and the rail connections are good. Some 200 carloads are used during a normal growing season by Davis Gardens.

Of interest too is the preparation of the growing area. Many problems that later might arise are eliminated by careful methods of sanitation and sterilization. About August 10th preparation for the fall crop begins. Sulfur is burned in the growing areas to dry up the vines of the previous crop. All vegetation is removed from the beds and burned in an outside area. The soil in the greenhouse is subjected to roto-tilling. A foot beneath the surface of the soil, a four inch drain tile has been laid in all the growing beds. After covering the soil with canvas, live steam is blown through the tile until the temperature of the soil is brought to 200°F. This method is believed to take care of any plant diseases, plant or insect life present in the soil. After being subjected to the high temperature for some time, the soil is found to have an extra-ordinarily high concentration of salts near the surface. Overhead sprays are employed to re-distribute the mineral through the soil more thoroughly. When this has been accomplished, manure is applied to the growing area and sprayed repeatedly with D.D.T. to eliminate the fly menace. In this prepared area the two week old seedlings are planted about November 1st. Various methods of cultivation, heading and securing a maximum number of laterals in a given length of stem, occupy the worker's time from planting till picking commences. Application of fertilizers is held to a fixed schedule during the period of cultivation and while the plant is bearing fruit. In addition to manure considerable quantities of commercial fertilizer are used. Commercial fertilizers used include muriate of potash, acid super-phosphate, and sulfate of ammonia. Minor elements such as copper, boron, zinc, and manganese are added to the soil at two or three year intervals. The plants are given a start toward climbing wire trellises which extend up the sides of the greenhouse and then horizontally toward the center where they join other structures originating in beds nearer the middle of the building. Since the cucumber plant is a vine, little difficulty is experienced



Fig. 2. Inside view of the Cucumber Greenhouse.

in keeping the plant growing upward. There are several reasons for this procedure: it causes more of the plant to be exposed to sunlight; it keeps the cucumbers off the ground where they become discolored or are subject to softening; and it provides a maximum growing area for a given amount of space. The first cucumbers are ready for picking about December 15th and within a month the average figure of 2000 dozen per day is usually reached.

Tomato Culture

The tomato cultures at Davis Gardens are of interest for several reasons. As was mentioned earlier, tomatoes are grown partly on an experimental basis. Work with hydroponics is carried on with the idea in mind of using it on a large scale when minor problems are eliminated. Two types of culture are used: the sub-irrigation type, or gravel culture, and the constant flow type, or water culture. The sub-irrigation type at Davis Gardens employs a water-tight growing bed six inches deep and three feet wide filled with some aggregate such as gravel or haydite, a cinder-like material. A half tile forms an inverted trough in the center of the bed under the aggregate. The bed is so constructed so as to have one end slightly lower to facilitate drainage. Water, containing plant food, is pumped through the tile several times daily, the number dependent upon the type of aggregate and the stage of plant growth. The object is to pump water into the bed until it reaches the upper level of the gravel and then allow it to drain leaving some of the nutrients in the aggregate where it is available to the plant. In the case of water culture, no aggregate is employed. The plants are supported by structures above the water beds and the plant roots are merely suspended in the solution. Care must be taken to keep the light from reaching the roots, and canvas or a similar covering may be suspended just above the water level as a preventative to the growth of algae on the roots. This method differs from the sub-irrigation method also in that the water is



Fig. 3 Hydroponics beds at Davis Gardens. Gravel culture at left and water culture at right.

constantly flowing rather than being changed at intervals during a given time period. The same nutrient solution is used over and over with periodic analyses being made to see that a sufficiently rich solution is maintained. The water culture employs the same nutrient solution as the gravel culture at Davis Gardens. The food itself is composed of all the major elements including calcium, magnesium, nitrates, phosphates, and potash with minor amounts of such elements as iron, copper, and boron. Formulas for the solution used at Davis Gardens were obtained from Purdue University.

Planting and potting methods used are similar to those used in starting the cucumber plant. One of the problems of tomato raising is the setting of the first hand, or causing the first cluster of tomatoes to form. To facilitate the early setting of the hand, the first two clusters of blossoms of each plant are sprayed with a hormone, indole-butyric emulsion. The rest of the hands are set by the workers daily tapping the plant which shakes the pollen loose and facilitates fertilization. Since both the stamen and pistil are present in each bloom of the tomato plant, fertilization is easily thus accomplished. The tomato plant, however, is not the climbing type vine that the cucumber is; consequently, the growing ends of the plant must be repeatedly wrapped around vertical cords which are attached to overhead structures. Conservation of space and presentation of more fruit to sunlight are basic reasons for this type of growing structure. Two crops of tomatoes a year are produced. The first yield is secured from April 1st to July 15th and the second crop from September 1st to December 1st.

In contrasting the products of the two hydroponics beds and those of a soil culture similar to that used in growing cucumbers, several facts come to the fore. The sub-irrigation method, as used at Davis Gardens, requires a shorter growing season, produces a higher yield, and is less costly than either the soil culture or the constant flow culture. Irrigation in the case of the constant flow culture requires $2\frac{1}{2}$ times the quantity

of solution since it is a constant flow proposition, and the pumps are operating 24 hours a day. This is a major item of cost in the latter type culture. The quality of tomatoes produced under each culture was so nearly the same that this factor was discounted.

Problems

Problems encountered in greenhouse work are many and varied but those of chief concern are plant disease and insects. The major factors which have been successful in combatting these two hazards are sanitation and sterilization. Preventative measures include fumigation before and after each crop with sulfur and azo-benzene. During sowing and potting periods all materials, insofar as possible, are sterilized and a high degree of cleanliness is required of the workers. Elimination of weeds in grounds between and surrounding greenhouses has been found to aid considerably in pest control. The red spider, a type of mite, is the insect that causes the most trouble at Davis Gardens. Preventative methods have been mentioned. Whenever a leaf is found that has been attacked by the insect, it is pinched off, taken outside, and burned. The area from whence the leaf came is then subjected to spot spraying with hexa-ethyl-tetra-phosphate. If a cluster of spots appear, the area is marked off and thus transference to other plants is held to a minimum. Azo-benzene is applied to the heating pipes in the area and thus is dispersed to the plants. Other insects that constitute problems are the aphid, thrip, and the cucumber beetle. The latter becomes a real menace usually late in the spring. A juice sucking insect, the beetle impregnates the plant with a type of bacterial wilt at the same time it is sucking the plant juices. D.D.T. has been found to be effective against this insect and is applied with the aid of aerosol D.D.T. bombs. Not all insects are effectively controlled with D.D.T. however. To combat the aphid and thrip, Davis Gardens use nicotine pressure cans. These instruments consist of a can with a restricted opening and containing nicotine mixed in a powder. When ignited the powder creates tremendous volumes of dense smoke clouds which contain the nicotine.

In controlling plant disease, prevention by sanitation and sterilization are foremost. Whenever a plant becomes diseased, it is removed and destroyed. The area must be isolated since it is very easy to spread some types of plant disease. Powdery mildew is probably the greatest enemy as to cucumber plant diseases at Davis Gardens. It is a mold that appears on the foliage and stems, and is caused mainly by high humidity and stagnant warm air. Sulfur applied to the steam pipes is effective in dehydrating the air and killing this trouble maker. It has been found that a good principle to follow is: keeping down insects keeps down plant disease too.

Distribution

Produce from Davis at Terre Haute is distributed throughout a market area from the Mississippi River to the east coast, and the services of an entire truck fleet are required to keep warehouses from

Canada to the southland supplied. A second plant at Davenport, Iowa in conjunction with one at Aurora, Illinois ships to the western areas. Timing involved in these shipping operations is important for several reasons. The product is a perishable one and delays are usually costly. Then too, as is true of many such products, changes in prices are often sudden; and, though the change per cucumber may be small, the total change on a truckload is considerable. The value of one truckload often exceeds \$10,000. Shipments in the early part of the season are usually to the New York area and Boston. A short while later Chicago, Cleveland, Detroit, Syracuse and others are added. Davis cucumbers have been shipped to Europe on occasion, but the producer's themselves did not do the shipping. Distribution from the large eastern wholesale houses was responsible for overseas shipment. It is believed, however, by Davis Gardens that their product entered the African continent under rather novel circumstances. A Davis official, in chance conversation with a fellow traveler, mentioned the company by which he was employed. The other traveler, an Army officer, asked if it was the same company that was concerned with cucumber raising. It developed that the officer had been in charge of one of the first supply waves to come ashore during the North African Campaign, and he had remembered the large volume of Davis cucumbers that were present in those supplies since they seemed an odd item of war material. It is possible that their purpose was to provide an item of freshness to what perhaps was otherwise rather drab food.

On the occasion of Will Rogers' visit to Terre Haute, the great humanitarian was conducted through Davis Gardens as a part of his seeing the interest spots of the city. Upon conclusion of the tour he is said to have remarked, "Well, I had to come all the way to Terre Haute, Indiana to find out there were people that grew cucumbers on purpose."