EXPERIMENT STATION
OF THE
KANSAS STATE AGRICULTURAL COLLEGE,
MANHATTAN.

BULLETIN No. 70—JULY 1897.

HORTICULTURAL DEPARTMENT.
S. C. MASON, M.S.,
Professor of Horticulture and Superintendent of Orchards and Gardens.
W. L. HALL, Assistant.

VEGETABLE GROWING.

INTRODUCTION.

THE free use of garden vegetables in their season is always conducive to the general health of the family, and while me find many tables well supplied with the more common articles from the garden, few families make a systematic attempt to extend the season of fresh vegetables over as great a part of the year as might be done.

In a large number of homes, especially those of the farmers, who ought to furnish their tables with the best the soil produces, there is too much of an unvarying round of salted meats, bread, and coffee.

That a good garden takes time and thought may be frankly admitted at the start, and these are what the busy farmer, in the hurry of getting in spring crops, is apt to think he can ill afford, forgetting that in all that constitutes the real welfare of his household the products of a good kitchen garden may be worth more than those of a large field. Few people who do make a garden make any attempt to get vegetables earlier than can be done by sowing seed out-of-doors after spring is far enough advanced to avoid frosts.

Occasionally a box of tomato plants or of early cabbage may be seen in a sunny kitchen window, and plants of transplanting size are

secured by the time spring is far enough advanced to admit of setting them in the open ground, but such instances of foresight are too rare.

The use of hot-beds or cold-frames and sash in gardening is almost unknown among western farmers, being confined to a few who combine small farming with truck gardening in the suburbs of rural towns.

One of the points that I want to urge most forcibly in this bulletin is, that the use of a few sash can be made profitable on very many Kansas farms; profitable in a financial way, from the increased supply of healthful food afforded for the table, and doubly profitable as a means of interesting the young people in garden operations and giving them ideas of farm life beyond the plow furrow and the "feed lot." I firmly believe that in the skilful use of a half dozen or a dozen sash the farmer or village lot-owner can so increase the variety and especially the range of season of his garden products as to make such an investment a profitable one.

USE OF HOT-BEDS AND COLD-FRAMES.

As the construction and management of a hot-bed, though a matter of general garden information, is not well understood by most farmers, it may not be out of place to give in a popular way in this bulletin the necessary directions.

The most important item of expense will be the sash. While a single frame of two sash can be made to serve a very useful purpose as a hot-bed, four more sash to accompany these as cold-frames would answer a very much better purpose, and many large families, once accustomed to such gardening, would find a dozen sash a part of their equipment that they would not again do without.

Construction of Sash. (See Plate I.)

The usual size of such sash is 6x3 feet, holding 3 rows of 10-x12-inch glass, 6 lights to the row. Double-strength glass of "A" grade will be found the most profitable to use in the long run, as it does not break as readily as the lighter and cheaper grades. The best grade of sash is made from fist-class southern cypress lumber, though redwood or good white pine mill answer a good purpose. Stock 1½ inches thick when dressed gives the best weight. Make the stiles 2½ inches wide, and the rails 4 inches. No cross-mountings are used, but 2 bars 1¼ inches wide run the length of the sash. These, with the stiles and top rail, are rabbeted ¼ inch wide and ½ inch deep to receive the glass. The glass laps like shingles, and the lowest light projects *over* the lower rail, which is only 1 inch thick. In pinning

the sash, the holes should be bored from the under side not quite through, so as not to allow the leaking of water from above. Through the middle of the stiles and bars a 5/16-inch iron stay-rod is run just beneath the glass, for the double purpose of preventing spreading and the sagging of the bars.

If the lower portions of the stiles and bars are chamfered away as much as strength till allow, less light will be obstructed by them.

The lights of glass should be firmly set, with large points and a short brad at each lower corner to keep them from slipping down, and then well puttied.

The sash should receive two good coats of paint, and be repainted as often as needed.

One of these sash complete weighs 45 pounds, and it is believed that it will last enough longer than a cheaply made one to well repay the extra cost. Other patterns of sash are in use, but this, copied essentially from that used by a prominent firm engaged in the construction of greenhouses, we have found to be the most satisfactory.

Plate I shows two rows of these sash as in use in our gardens. It is believed that with the aid of this cut and the above description any competent carpenter can construct such a sash, that will give good service. They cost us, made in the College wood-shops, about $26 a dozen, complete.

The Frames.

The frames to support the sash may be made movable, six feet square, or fixed in rows to suit the demand. A good movable frame is made of one-inch stuff, 10 inches high in front and 18 at the back, strengthened at the covers with pieces of 2 x 4 scantling. This gives a slope of eight inches to the south for the sash. The sides should be made the thickness of the sash higher than the front and back, with a cleat on each side flush with the front and back, on which the sash will rest. A four-inch piece of board through the middle of the frame, where the sash meet, is dovetailed into the front and back, so that it can be readily removed for filling or sowing the frame and then be put in place as a slide for the sash to move upon. A four-inch strip should be nailed across the back from side to side and even with the top of the sides of the frame.

A stationary row of frames may be built in a similar way, of any rough lumber at hand that can be made tight enough.

Location.

The location of a row of frames should be a sunny, southern exposure, with a good windbreak, as a building, stone wall, tight fence or hedge on the north. Much of the success of the venture will depend upon the degree of protection secured from the sweeping north

winds of a prairie country, and the added heat secured by reflection when the frames are on the sunny side of a wall or tight fence is an important item.

Methods of Heating.

Flues or rows of tile running beneath the beds and conveying the hot air and smoke from a small furnace to a chimney at the opposite end afford the method of heating often used by commercial gardeners; or some even use coils of pipe heated by steam or hot water. The small gardener and farmer, however, will depend almost wholly upon the heat developed by a pile of fermenting manure beneath the beds. Upon the proper preparation of this the success of the whole enterprise will largely depend, and lack of attention to certain important details, homely though they may be, will insure failure at the outset. For this reason I shall give quite full instructions upon the

Preparation of Hot-bed Manure.

Good horse-stable manure, with not too much straw or litter, is the best material. It should not be fire-fanged or burned out, or it develops only a very mild heat.

About the last of February or 1st of March for northern Kansas, or earlier, according to locality, a pile of manure sufficient in quantity to make a bed 18 inches deep under the sash to be used should be hauled to the place needed, forked over evenly, any dry portions being wetted well, and built up into a compact mound. After a week or 10 days the steaming of this pile will indicate that fermentation is well under way, when it should be thoroughly forked over into another pile, pitching the outer portions of the first toward the center of the second, again wetting all portions that are dry and making all of as even a consistency as possible. By another week it will again be in a strong fermentation and ready to build into the final bed.

Some prefer to dig a pit of the area of the frames to be used, into which the manure is packed. This is more protected from the cold, and if the beds can be left in the same place year after year it is a good plan. Others prefer to build the bed on the surface of the ground, in which case it should be a foot beyond the area of the frames, on all sides. On the care and skill with which this final building up of the manure bed is done much of the success of the undertaking depends. The material should be carefully shaken over, made of even texture throughout, well moistened, and thoroughly and evenly tramped down. Evenness of settling and evenness of heat both depend upon the care with which these instructions are followed.

The frames are next put on, about five inches of fine, rich garden loam filled in, and the sash put in place. The frames should be well banked around with strawy manure, to keep out the cold. A thermometer in the soil should be watched, and the heat in a few days

will often be noticed to have run up to 100 deg. Not until it drops to 80 deg. should seeds be sown, or the young plants will surely be burned out.

Of the scope of work that may be done with these hot-beds only a few things need be mentioned here. Radish and lettuce, for early use, will be among the first things sown; seeds of early cabbage and cauliflower, and later of tomatoes and eggplant. Early Frame or Early White Spine cucumbers may be started in small flats or berry boxes, to be transplanted into cooler frames later. One who is provided with a number of sash need not start all of them as hot-beds. As soon as cabbage and cauliflower are large enough they should be transplanted into cold-frames, which are simply the same frames filled with soil without heat below, and managed as cool as possible, so as to get hard, firm plants to set in the open ground. These are only a few hints as to what may be done with a lot of sash.

The care and management of the frames is a matter of importance, and is one that requires such attention as can hardly be given by the farmer who is trying to put in a full day's work in the field, but often there are less active members of the household who can give them the necessary care. As soon as the sun's heat begins to warm up the air well and the temperature within the sash rises a little, the sash must be opened a trifle, either by sliding down; or by raising the lower end with a block. The direction of the mind and the temperature of the outside air will govern the amount of this. Should the sun cloud in or a cold mind spring up during the day, the frames must be closed, and early closing at night is necessary in order that the warmth absorbed by the soil during the heat of the day may not too soon radiate.

For cold nights gardeners are often provided with mats with which the sash are closely covered, but every purpose is answered with a few sash by covering with hay or straw held in place by a few poles or strips of board. For the protection of the young plants as they emerge from the ground, and till strong and firm, lath screens should be laid over the sash to shut out a part of the light.

Regular and judicious watering should not be neglected. But little till be needed after the seed is sown till the young plants are good and strong, and many a lot of seeds has been rotted in the ground by reason of overzeal in the matter of watering. Especially if the seed is of low vitality it will not stand as much as stronger seed.

A light stirring of the soil now and then must not be neglected, as nothing is more quickly fatal to plants under glass than a baked condition of the soil.

Only very general directions as to the frame management can be offered here, but one who will make a small beginning will gain the skill and experience which will enable him to push ahead.

CULTIVATION OF CAULIFLOWER. (See *Plates II and III.)*

This vegetable is identical with the cabbage in its origin, but affords one of the best examples of the results that may be obtained in a given direction by careful selection and culture. It requires somewhat more of care to grow successfully, and is more dependent upon the particular weather it needs for its best development than is the cabbage. It is also much more perishable, and must be cut almost to a certain day to be secured at its best. It is doubtless for these reasons combined that cauliflower is scarcely known in our local markets, and is an unusual sight in many of our smaller Kansas towns.

This season, for the first time, we have grown this vegetable in such quantities as to more than stock the home market, and have been surprised to find how many people are entirely unfamiliar with its use or merits. As people become more familiar with it its consumption will doubtless be greatly increased, and it is with the hope that its culture may become more general in the farm and village garden that these experiments have been made as here outlined.

Cauliflower requires a rather cool temperature in which to develop the best heads, and hence in the warmer portions of the United States it must be managed so as to mature the heads in May or June, before extreme hot weather sets in, or else the seed must be sown late and the plants grown so as to reach the heading stage in the autumn months. If plants head during the hot weather, no matter how moist the ground may be, the flowers tend to be loose, dark colored, and strong in flavor.

In order to secure early cauliflower in this latitude, as a rule, plants must be started in hot-beds or flats in the house by the middle of February, and transplanted into cold-frames for awhile to harden up. They will then bear a considerable frost in the open ground without harm.

Experiment of 1897.

Seed of Henderson's Early Snowball and Early London cauliflower were sown in shallow boxes or flats in the propagating pits February 17.

By the 12th of March the young plants were large enough to transplant, and they were set in the bench that had just been cleared of the third crop of lettuce. They were set four inches apart each way in a rich soil, and as soon as they were well established, were given plenty of air and the house kept cool, so as to produce a firm, hard growth able to endure a good deal of cold.

The ground selected for cauliflower had been heavily manured the

year before, and about the 1st of April was deeply plowed and brought into fine condition with the harrow.

April 6 and 7 the plants were set in the open ground, in rows 3½ feet apart, plants 20 inches apart in the row. Of the Early Snowball 1,500 plants were set in about 30 square rods of ground, or at the rate of 8,000 plants to the acre, while 330 plants of Early London were set at the same distances.

Clean culture, keeping the ground with a mellow surface, gave an even and rapid growth. On the 24th of May, there having been a dry period of several days, irrigation was begun. The water was turned into a broad furrow opened between the rows, and the supply kept up till the ground was well soaked. When the water had dried away so that the ground was no longer muddy, the furrows were leveled in and worked down to a fine, loose surface with the cultivator.

At this date many heads were beginning to appear, and this and the succeeding weeks may be regarded as the most critical time in the history of cauliflower. The growth is rapid and large demands are made on the soil moisture.

Here is illustrated the advantage of being equipped for irrigation. The rainfall for the season was abundant, and the dry period was a short one at this time, there being an abundance of moisture in the deeper soil during all of it, but a good irrigation, not allowing the crop to flag at all, put the plants far ahead of what they would have been without it.

As soon as the heads reached the size of three or four inches across, the large outer leaves mere caught up and tied over them with a string, to protect them from the sun and insure a perfectly white product.

Early Snowball.

The first two heads were ready to cut June 1, though it could scarcely be called a cutting till June 7, when 20 heads were gathered. On the 12th 75 heads were ready, and on the 19th 225 heads, our heaviest cutting.

The weather up to the middle of June had been the very best, the mean temperature, according to the weather records for the last 10 days in May and the first week in June, the period during which the most of the growth in heads was made, being 65 deg.

The quality of the cauliflower cut up to this time had been very fine, the heads being white, solid, tender, and of excellent flavor. They averaged about seven inches in diameter, and weighed on an average 1.8 pounds each, trimmed for market. From June 16 on succeeded four very dry, hot days, and the weather did not again recover its previous coolness, the mean temperature for the last half of

June being 82 deg. The influence of this change was at once noticeable in the character of the cauliflower heads. The cutting made June 19 was not of as sound and fine a character as the previous ones, the heads being disposed to "pop out," and were of a more green color and stronger in flavor. The cutting of June 28 had been delayed four or five days longer than it should have been, as the market had fallen off so that there was little demand for shipment, but at this time a large portion was too loose and dark colored for market.

Plate II shows a half dozen heads of Henderson's Early Snowball, reduced to one-fourth actual size. These are about as fine and perfect as can well be grown. They were grown in a mean temperature of 65 deg. from the time they began to head.

The character of the more loose, dark-colored product which we secured during the succeeding hot weather mill be well illustrated in plate III, which is from a photograph of Vaughan's Early Dwarf Erfurt, taken in July, 1896. The mean temperature for the 30 days preceding the cutting of this was 78 deg. While still a marketable cauliflower, it was much less desirable in quality and stronger in flavor.

In Kansas City markets the Erfurt is rather the favorite cauliflower, and certainly produces excellent, firm, white heads where grown under favorable conditions. Plate III illustrates perfectly the character found in our late cuttings of both Early Snowball and Early London. The difference must be attributed almost wholly to the higher temperature under which it was grown. The ground during the last half of June of this year was in excellent condition as to moisture, but during the heated days the leaves of the cauliflower would wilt and fall down, and the heads grow loose and dark in spite of that fact.

Yield.

From the 1,500 plants set, 1,062 heads were harvested, having a total weight of 1,614 pounds.

Early London.

The Early London proved at least 10 days later than the Early Snowball. The first cutting of six heads was made June 17; 51 heads were cut on the 19th, and 41 on the 28th, so that from the 330 plants set of this variety but 98 heads were gathered, a much lower percentage of heading than was secured from the Early Snowball. On June 28, a comparison of varieties showed that the 12 largest heads of Early London weighed 26 pounds, while 12 heads of Early Snowball were found weighing 29 pounds. The Snowball was the best in both appearance and quality all through the season.

Extra Manuring.

A strip of ground directly east of the above-described plantings was given additional manure, at the rate of 60 loads to the acre, and was plowed just before the setting of the plants. On this mere set 2½ rows of Early Snowball and a half row of Early London. The heads when cut averaged about the same in size and quality as the others, but of the 287 plants of Early Snowball set, 220 made heads, or about 79 per cent., as against a little less than 71 per cent. on the ground manured the previous year. So slight a difference would indicate either that the ground was about rich enough for this crop, or that the manure applied so late did not become available in sufficient quantity to benefit so quick a crop as cauliflower.

Time Needed for Crop.

To one planning for a crop of cauliflower, the following dates will be of interest as a guide to operations, remembering that the time must vary with the place and season, and that these dates are given as suggestions only:

Early Snowball Cauliflower

Seed sown in flats, February 17.
Transplanted to benches, March 12; from seed, 23 days.
Set in open ground, April 6; from seed, 48 days.
First heads noted, May 24; from seed, 96 days.
First marketable heads, June 1; from seed, 103 days.
Heaviest cutting, June 19; from seed, 121 heads.
Entire crop marketable, June 25; from seed, 127 days.

The time of the crop in the open ground was 79 days, leaving abundant time for another crop of some late truck upon the land.

During the time these plants were out there were several sharp frosts which they endured well, and I am of the opinion that a crop could be brought to maturity several days earlier than this was by starting still earlier.

Although we ran these plants in flats and benches in the propagating houses for the most part, a part of them were carried in cold-frames, and the whole process might have been carried on with one sash of a hot-bed for starting the plants and a dozen for cold-frames to transplant into. This space would allow for 2,000 plants, or enough to set one-fourth acre. Of course a family garden would want but a fraction of that.

EARLY CABBAGE.

For the past two years some attention has been given by the department to the question of growing extra-early cabbage. Two methods of culture have been employed, either of which has shown the feasibility of putting heads upon the market from one to two weeks ahead of the usual time.

The method which I shall describe first gives greater earliness, and, as it does not require the use of the forcing house, is more generally available.

In September the seed is sown in flats and kept where the young plants can be sheltered from possible frosts during the night. In a month or six weeks the plants are set in a cold-frame, where they are kept during the winter. The frames should be well banked up to protect against freezing, and some kind of extra covering for the sash must be provided. Matting made for the purpose is perhaps the handiest, but a convenient pile of straw or strawy manure can be made to do effective service. The plants must be watched on warm days as well as cold. Rapid growth is not desirable; there is danger both of the plants outgrowing their quarters and of their becoming too tender. Watering should be only frequent and heavy enough to keep the plants healthy. Whenever the weather is not too cold, the sash should be lifted and the plants exposed to harden them. This last should be looked to, especially as the season approaches for transplanting into the open field.

There is little need of cultivation, as a slow growth is the thing sought for. The plants will need to be inspected for the cabbage aphis *(Aphis brassicæ)* which is likely to appear in considerable numbers when the spring weather begins. This insect is easily destroyed. Spraying with kerosene emulsion or tobacco water, or evaporating carbon bisulphide among the plants under a close cover, are, any of them, effective methods.

The plants may be set in the open field usually by April 1. The ground should be plowed very deep and should be loose; if not, the work of setting will be quite laborious, for the plants have to be set 6 inches or more in the ground. Our practice has been to trim off all the leaves but about the top 5, and then set the plant in until the leaves come within 3 or 4 inches of the ground. In 1896 plants of Early Jersey Wakefield and Burpee's All Head started in this way and set April 8 produced edible heads by June 5.

The other method calls for a greenhouse, or at least a hot-bed. Seeds are sown in flats early in February and transplanted into good soil in the greenhouse bench in about a month. They should have

plenty of light and such watering and cultivation as will induce a healthy growth. The house should be kept rather cool than otherwise, the ventilators being kept open as much as possible to harden the plants. These plants will not stand so much cold as the ones kept over winter, but if properly prepared for it they will endure some frost, and will make a quick start and a vigorous growth if the weather is not too severe.

This year's notes show for Early York: Seed sown in flats February 10; plants set in greenhouse bench March 12; transplanted to open ground April 6; heads were of edible size by June 23; on June 30, 4 heads cut gave average diameter of 4.5 inches, average weight 2.87 pounds.

The following notes on Charleston Wakefield cabbage mill give an idea of another method which might be made earlier in its operation: Seed sown in hot-bed March 4; on April 15 they were transplanted to the cold-frame, and were set in the open field May 6; on June 29 heads were of edible size, small but very solid, the four largest giving a diameter averaging 4.62 inches, and weight averaging 1.5 pounds.

The past winter the plants in the cold-frame were rather severely nipped by frost once or twice, but they seemed to recover sufficiently. However, as the temperature was at no time, either then or the winter before, lower than 4 deg. below zero, it may still be a question as to whether plants can be carried over every winter in this manner.

ASPARAGUS CULTURE.

Test of Varieties, and Experiment in Manuring.

In the spring of 1894 the seed of 10 varieties of asparagus was planted. A good stand was secured, and the young plants were cultivated during the summer in the usual way. Early the following spring the entire patch was dug up and the roots heeled in. The same ground was then prepared for a permanent plantation by plowing it deeply and marking it with furrows 4 feet apart. These furrows were made as deep as possible, but after the loose dirt had run back into them they were on the bottom hardly 6 inches below the level of the ground. In these furrows the roots of the seedlings mere planted—240 feet of row for each variety—making all together a patch of 35.25 square rods, or a little more than one-fifth of an acre (.22 of an acre), The plants were set about a foot apart in the row, and covered only an inch or two above the crown, leaving along the rows depressions some 2 inches deep, which were gradually filled up during the summer by the many cultivations. During the winter the stalks

were cleared off, but nothing was done with the patch in the spring more than to cut and note the earliest shoots, the first cutting of which was made April 13. The patch was cultivated this summer as before, except that the size of the plants interfered somewhat-many of the plants growing 6 feet high and correspondingly broad. During the fall the north half of each variety was manured at the rate of 50 loads per acre of strong barn-yard manure, and in the spring the effect was noted.

The following table gives results as shown by the records of 10 cuttings made the spring of 1897, from April 20 to May 19, inclusive; varieties averaged in order of yield:

VARIETIES.—240 feet of row in each, one-half manured and one-half unmanured.	YIELDS IN POUNDS.		
	Manured.	Unmanured.	Total.
1. The Hub	31.345	27.201	58.546
2 Donald's Elmira	29.073	28.893	57.966
3. Vick's New Mammoth	26.297	20.593	46.890
4. Palmetto	20.418	18.545	38.963
5. Moore's Cross-bred	19.321	15.463	34.784
6. Conover's Colossal	15.845	17.140	32.985
7. Barr's Philadelphia Mammoth	16.783	15.978	32.761
8. Columbian Mammoth White	18.123	13.540	31.663
9. Dreer's Eclipse	16.555	13.924	30.479
10. Giant Purple Top	14.950	13.977	28.927
Totals	208.710	185.254	393.964

Of the two heaviest yielding varieties, The Hub and Donald's Elmira, the last named is the earliest, though The Hub is also quite early.

As nearly as can be judged from the notes, the ten varieties rank for earliness about as follows, though all kinds yielded something at the first cutting:

{10. Giant Purple Top.
 7. Barr's Philadelphia Mammoth.
 2. Donald's Elmira.

{6. Conover's Colossal.
 3. Vick's New Mammoth. 1. The Hub.

 9: Dreer's Eclipse.
 4. Palmetto.
 5. Moore's Cross-bred.
 8. Columbian Mammoth White.

Those included within a brace have little or no difference of season. The numbers mark their rank with regard to yield, 1 being the highest.

The ground occupied by this plantation is a rather low bottom land, being built up of a clay silt from the former overflow of two

creeks, mixed with vegetable mold. It is rather too compact for the best growth of asparagus, as it contains very little sand.

Winter Growing.

During the past two winters we have been moderately successful in raising the stalks under a bench of one of the propagating houses.

The experiments were not really directed to finding the best method of asparagus forcing, but were rather attempts at utilizing the space under the benches, and asparagus among other crops was tried for this purpose. The work of growing, as we have done it, is briefly as follows:

About the middle of October the roots to be used were dug, from the patch and buried where they could be got at conveniently during the winter.

On the ground under the flow pipe of the tomato house a bed three or four inches deep was made of rich soil (four parts garden loam and one part well-rotted manure). On this the roots mere placed thick enough to cover the surface completely, or about one plant to every 10 inches square, and then covered with another layer of soil of the same thickness as the first.

The bed was well wet up as soon as the planting was done, and kept so by thorough but not frequent waterings. No cultivation was given, as the soil remained loose and mellow.

Stalks large enough for cutting are ready two weeks after the bed is made, and in about six weeks the roots become exhausted, so far as the production of edible sprouts is concerned, and have to be replaced by new ones. In quality the stalks are as good as any, but they lack in size and vigor.

The flow pipes from the boilers lie less than two feet above the soil, and besides making work there hot and inconvenient evidently have a good deal to do with the slimness of the stalks.

Our last crop, and most successful one, lasted for 33 days, and yielded an average of a pound a day; this from a bed covering 224 square feet. At the ordinary prices the receipts for this would but little more than pay for the work. It is probable, however, that the one could be increased and the other decreased considerably if the work was taken up in a commercial way.

Varietal tests have been attempted in connection with this work, but the small number of plants grown and the chance for other irregularities in conditions make the figures of doubtful value. Donald's Elmira has, however, shown a superiority which safely entitles it to a preference.

EARLY POTATOES.

Any method by which earlier potatoes can be obtained than by the ordinary planting is desirable both in the family garden and the trucker's field, as a few days, even, make a great difference in the value of such a crop.

A method, practiced by English gardeners, and described by J. WRIGHT, F. R. H. S., in his "Ten Lectures Delivered before the Surrey County Council," was given a trial here last spring with such success as to be worth reporting upon.

On February 23, four of the common greenhouse seed flats mere filled with even-sized tubers placed on end with the "seed end" or apes up, and were filled around with sand, leaving the upper fourth of the tubers exposed. Forty-four tubers filled a flat, and one flat each of the varieties White Ohio, Beauty of Hebron, Early Harvest and Carman No. 1 was prepared These flats were set under a bench in a cool propagating house, where they received partial light and a temperature of from 50 deg. to 65 deg Strong sprouts began to push from the exposed eyes, very different in appearance from those of potatoes sprouting in the dark and in bulk.

On March 22, all of these lots were planted in furrows, the tubers being removed carefully from the sand and planted, entire, in the same position in which they stood and 14 inches apart in the rows. As a check against this a similar parallel row of each sort was planted of whole tubers selected from the potatoes stored in the cellar As they grew the sprouted potatoes took the lead in strength and vigor of tops from the start, and both lots of whole seed kept ahead of cut seed of the same varieties.

On June 1, the sand-sprouted lots showed excellent young table potatoes, while none of the others were yet fit for digging. While difficult to judge precisely of, there seemed to be fully a week in favor of the sand-sprouted seed.

The following tables show the comparative yield of 10 hills each of the sprouted and unsprouted lots dug June 16, and of the balance dug July 24 .It will be observed that the proportional difference is greater with the early digging than the later, and that the difference in the ripe tubers would not be sufficient to make the experiment pay for the trouble. The real gain was found in the examination made June 1, which gave table potato a week ahead of the ordinary method.

POTATOES planted March 22. 44 hills (44 tubers) of each lot.	Tubers started in sand. Yield in pounds.			Tubers started in cellar. Yield in pounds.		
	Total.	Marketable.	Unmarketable.	Total.	Marketable.	Unmarketable.
10 hills dug June 16:						
Beauty of Hebron	13.	10.5	2.5	11.	10.	1.
Carman No. 1	24.	22.	2.	12.5	11.	1.5
Early Harvest	17.	15.	2.	14.	9.	5.
White Ohio	17.5	15.5	2.	15.5	14.	1.5
Totals	71.5	63.	8.5	53.	44.	9.
34 hills dug July 24:						
Beauty of Hebron	37.5	30.	7.5	35.5	29.	6.5
Carman No. 1	39.	36.	3.	27.5	26.5	1.
Early Harvest	21.	17.5	3.5	20.	15.	5.
White Ohio	41.5	35.5	6.	36.	31.	5.
Totals	139.	119.	20.	119.	101.5	17.5
Totals for both diggings	210.5	182.	28.5	172.	145.5	26.5

SOME ONION NOTES.

1893 TO 1897, INCLUSIVE.

In 1893, the department carried on an extensive varietal test with onions, in which were included nearly 100 varieties. It is not expedient here to give the long list of comparisons and descriptive notes that were made at the time, but it is sufficient to say that our conclusions with regard to preference of varieties coincided with the opinions, based on more extensive trial, of commercial growers generally. We have a World's Fair medal awarded that fall on Prizetaker onions, a variety which has kept the lead with us ever since.

In l894, onions, among other crops, were used in a test of fertilizers, and except in that connection the notes are of little interest. The crop was not a success, but enough of a crop was secured to show that barn-yard manure—a heavy application—gave better results than any of the more concentrated substances.

In 1895, onions, among other crops, were used in testing the effect of subsoiling and irrigating. Four blocks, each 450 feet long, of a uniform grade of soil, and lying side by side, were prepared and treated as follows: Block I, plowed only in the ordinary manner and irrigated; block II, subsoiled and irrigated; block III, subsoiled but not irrigated; block IV, neither subsoiled nor irrigated. One row each of Prizetaker, Yellow Danvers, Red Wethersfield and Silver King was planted in each block. Seed planted April 3; bulbs gathered September 12. Yield is shown in following table.

BY BLOCKS.			BY VARIE'ITES.	
Block I..	167	pounds.	Prizetaker..	291¼ pounds.
" II..	244	"	Yellow Danvers	126 5/8 "
" III.	102 7/8	"	Red Wethersfield..	134 "
" IV	173	"	Silver King..	135¼ "

It will be noticed that block II, the one both subsoiled and irrigated, gave much the heaviest yield, while block III, subsoiled but not irrigated, yielded less than half as much. The season was quite dry, so that an increase in the space for holding mater coöperated with the decrease in water-supply to work a hardship to the plants.

In keeping qualities the four varieties ranked: Westersfield, first; Danvers, second; Prizetaker, third; And Silver King, fourth. The onions from block III kept much the best, only about one-seventh as many of them as of the other lots being rotten at the winter sorting.

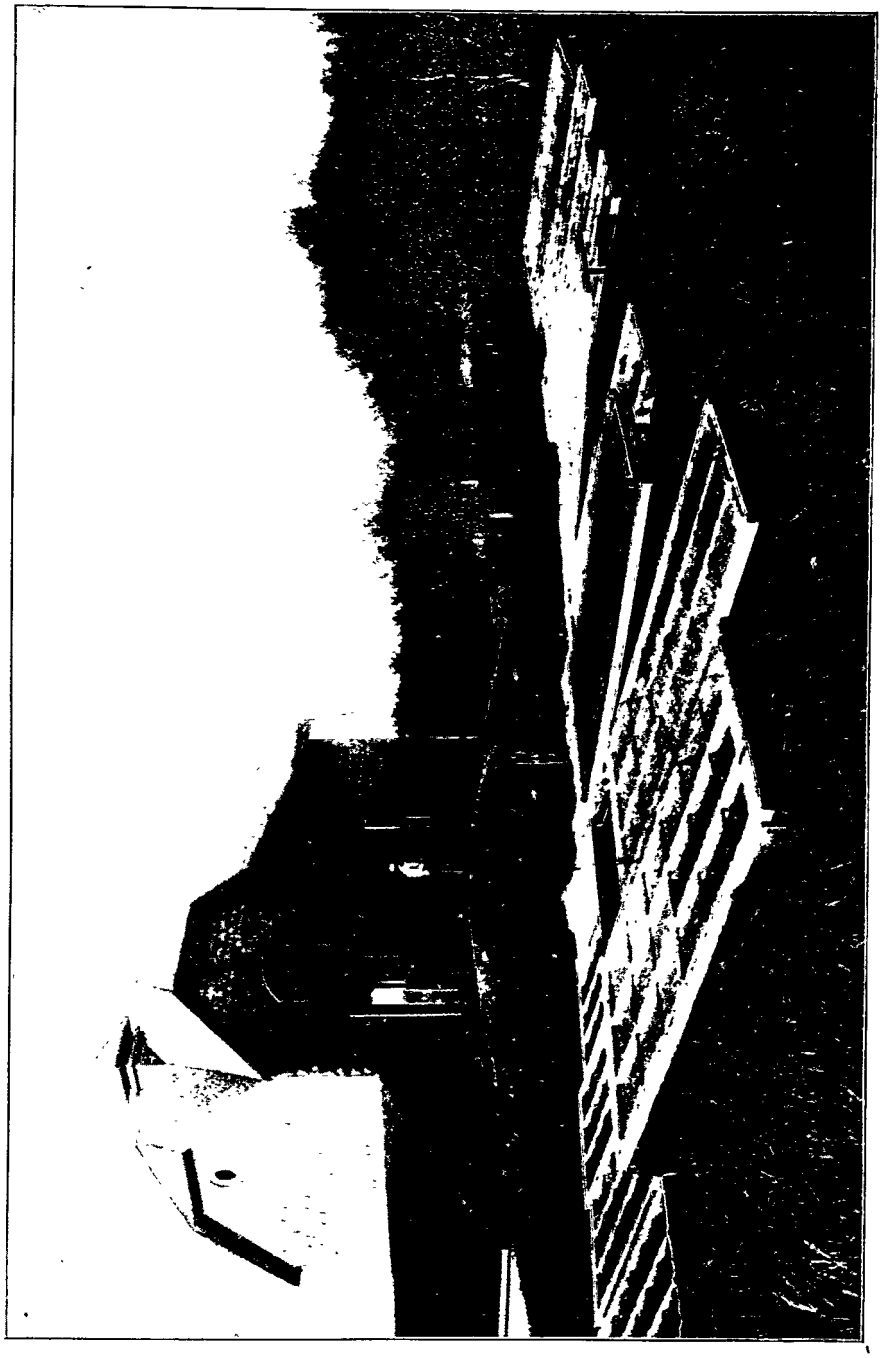
This crop was considerably damaged by the thrips, which appeared about the middle of July, and were only held in check by persistent sprayings with kerosene and water. As the two liquids did not always mix thoroughly, some of the onion tops were injured by the oil. In all subsequent operations we used an emulsion in place of a mechanical mixture.

In l896, 10 varieties were planted in the same ground for the purpose of continuing the experiment of 1895, but the thrips ruined the crop entirely.

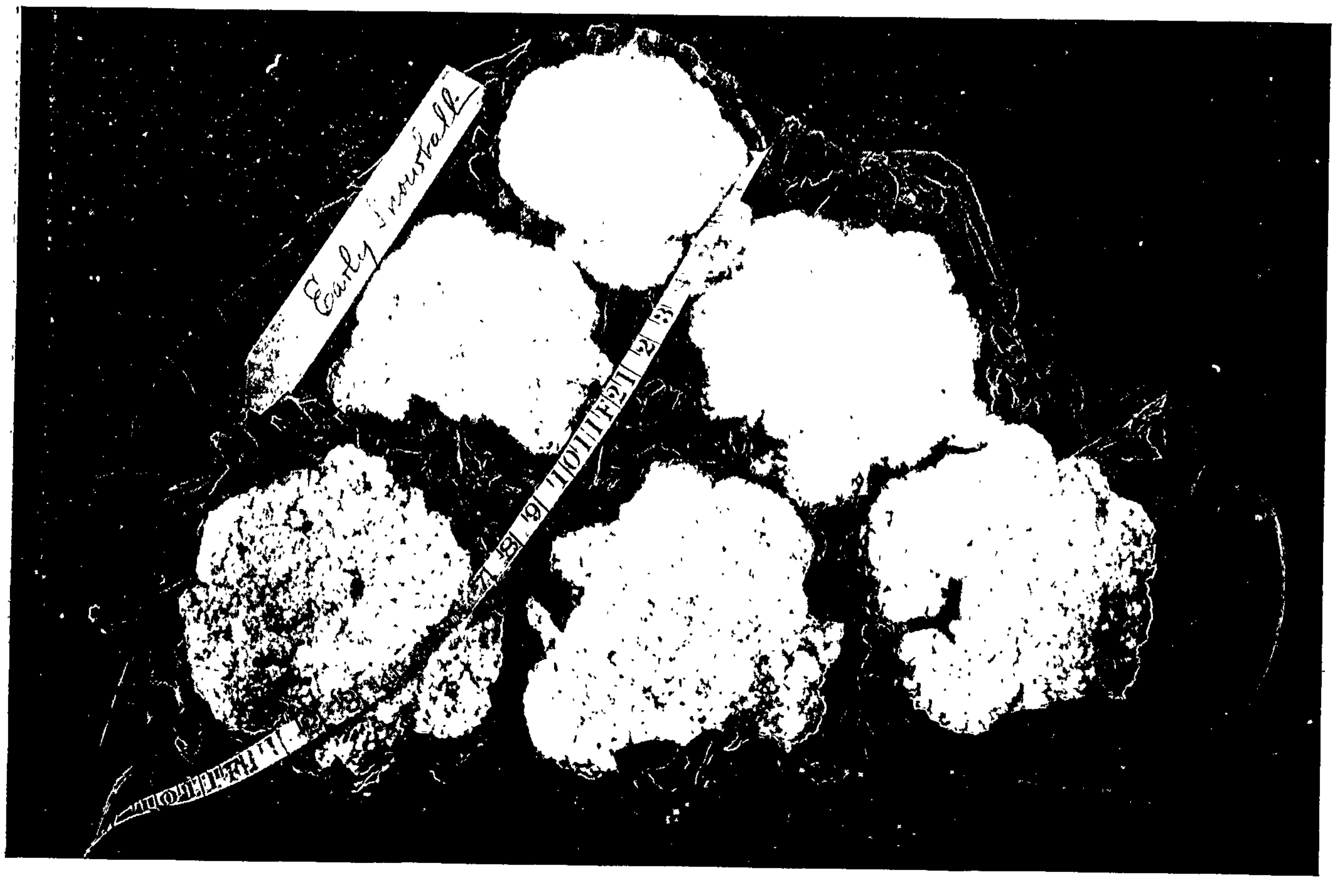
Up to this time we had followed in our culture the "regular or old way," as defined by T. Greiner, in his excellent little book on "Onions for Profit"; that is, we planted in April seed at the rate of six pounds per acre in drills 12 or 14 inches apart, thinning the plants after they were well up, so that one good plant for about every two and a half or three inches remained. Mr. Greiner strongly recommends what he calls "the new union culture," which differs from the old in that the seed is sown under glass in February or March, and the plants set in the open ground about the first of May, cutting back the tops (and roots, too, if they are long) and putting them three inches apart in the row.

In 1897, our work with onions included, besides a test of a few leading varieties, a comparison of the two methods of culture just alluded to, viz., the "old way," growing directly from seed, and the "new culture," or growing from plants started under glass. It also included, incidentally, a series of hard-fought battles with the thrips. The notes for the year are as follows:

February 22, seed of Yellow Globe, Danvers and Southport White Globe was sown in the hot-bed; and February 27, seed of Prizetaker was sown in a bench of the lettuce house. The seed was sown in drills four inches apart, and rich, mellow soil was used in both cases.

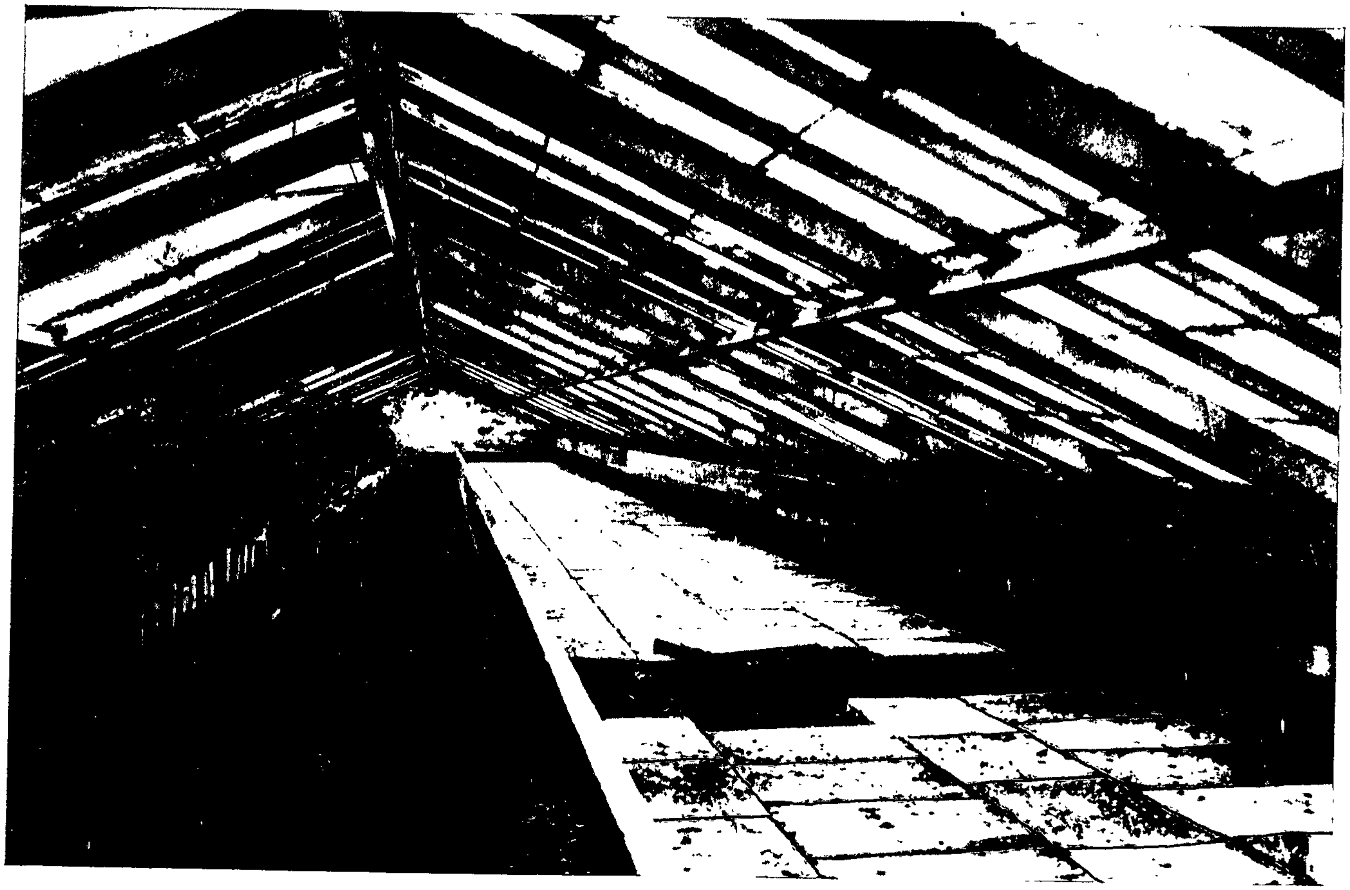


I.—HOTBEDS.



II.—HENDERSON'S EARLY SNOWBALL CAULIFLOWER.

III.—VAUGHAN'S EARLY DWARF ERFURT CAULIFLOWER.



IV.—THE LETTUCE HOUSE.

V.—THE TOMATO HOUSE.

On April 1 seed of all three varieties was sown in the open field, and on April 19 the plants from this seed began coming up.

May 5, the plants started in the hotbed and the forcing house were set in the same field, at which time they were perhaps six inches high, with bulbs one-fourth inch in diameter. The plants were cut back about two inches before setting. At this, time the soil was rather dry, and the weather not entirely favorable for transplanting.

The field in which the onions grew is a level piece (35.6 square rods) of clayey loam, which, however, is made quite sandy across the south end by wash from a hill. The rows, 231 feet long, ran north and south the length of the field, and were 14 inches apart. The plants after being thinned stood three inches apart in the row.

On June 17 and 18 the field was irrigated by plowing light furrows between the rows and running water down them till the ground was soaked.

July 6 thrips in large numbers were noted, usually between the two youngest leaves of the plants. The tops already had an unhealthy appearance. July 7, the patch was sprayed thoroughly with kerosene emulsion (a 10-to-1 solution of the standard mixture. See Rule-Book, Bailey). July 8, but little abatement of the thrips was noted. July 9, patch sprayed again with emulsion, with apparently more effect. On July 12, thrips noticed in small numbers; sprayed with emulsion the same day. July 14, larvæ of thrips again appearing, were sprayed as before. July 16, sprayed again with the same mixture. July 21, ditto.

On August 12 the onions were pulled and piled in rows. Most of them were of inferior size, owing to the ravages of the thrips. Below is a table of the product:

	Varieties.	*Area, square rods.*	*Yield, in pounds.*	*Rate per acre, pounds.*
Old or regular way.	Prizetaker, 12 rows	11.88	921.	12,483
	Yellow Globe Danvers, 14 rows	13.86	648.	7,535
	Southport White Globe, 6 rows	5.94	226.75	6,153
New culture.	Prizetaker, 2 rows	1.98	150.25	12,200
	Yellow Globe Danvers, 2 rows	1.98	55.50	4,513
	Southport White Globe, 1 row	.99	56.50	9,262
Totals and average		36.63	2,058.00	8,989

The thrips (*Thrips striatus* Ost of the family *Thripidæ*) which have played such an important part in onion economy are discussed somewhat fully by Professor Gillette in bulletin No. 24 of the Colorado Agricultural College Experiment Station. The insect has been "doing serious harm to onions" in different parts of that state "during the past two summers." The treatment recommended is that which we have been following, with the additional suggestion that the spraying be done early in the morning, when the insects are less active

and will not escape. As our method of culture has not been given in full, a few points may be added here: Whether for plants or for seed, the ground should be well drained (naturally or artificially), very mellow, finely pulverized, smooth (having neither hollows nor ridges), free from weeds, and quite rich. If you have no soil which is "that way," get it "that way " before planting onions.

Weeds should not be allowed to make a start in the patch. The frequent cultivations necessary to prevent this will keep the surface loose between the rows, and this gives good protection against drought. Wheel hoes and hand weeders have proven our most serviceable instruments. There are many points that must come from experience, or are already common property in good garden craft, that cannot be taken up here.

A ground more sandy than ours, and one which drains more readily after a rain, is a much better one for this crop. A field of onions calls for about the most hard work and careful attention of any crop that the farmer can handle, but in nothing can more satisfactory returns be realized, if the conditions are the best.

EXPERIMENTS IN FORCING LETTUCE. (*See Plate IV.*)

These were carried on in house No. 6, one of a range of ridge-and-furrow, even-span houses belonging to the Station. The dimensions of the house are 12 x 70 feet, 7 feet high at the ridge, and it has a roof pitch of about 24 deg. It is heated by 272 feet of 4-inch cast-iron pipe (two flows under one bench and two returns under the other), which gives a radiating surface of 285 square feet, making the ratio for the house about 1 to 3. The temperature of the house (45 to 65 deg.) would indicate a slightly lower ratio than that, but the difference is readily accounted for by the fact that ventilation from the outside was kept up a good share of the time, and frequently the heat was partly shut off.

In l894 a small crop of lettuce gave good returns at first, but was somewhat injured by leaf rot later in the season.

The first setting in 1895 proved a total failure, owing to the fact that fresh soil had not been put in the benches since the previous season, though sand and manure were added to the old bench soil till it was brought to what seemed a good condition. Plants from flats were set in this bench October 31, and within a week the lettuce rot appeared. Resetting, picking the diseased leaves, dusting with lime and fumigating with sulphur failed to check it, and December 1 the soil was removed and the bench, which was an old, decayed one, and too low to give the best light, was removed and the premises well

fumigated. This bench was replaced by a higher one with a tile bottom, which, however, was not used for lettuce until the following winter.

The next experiment embraced, besides a variety test, a study of different grades of soil for the work in hand. For this purpose the iron and slate bench on the west side of house No. 6 was divided into eight blocks of eight feet each, which were filled five inches deep with soil varying in composition from pure garden loam in block I to three-fourths sand, plus one-fourth loam, in blocks IV and V, and back again to pure loam in block VIII, the blocks numbering from north to south in the bench.

Our methods of culture, which seem to accord with the general practice, and which have proven entirely satisfactory with us, are as follows: For seed-bed we use 2½-inch flats filled with sifted garden loam, mixed with one-third its bulk of clean sand. This is firmed moderately and the seed sown one-eight-inch deep in drills two inches apart. When the plants are 1½ inches high they are pricked out into similar flats, but of richer soil, and set at distances of two inches each way. After an inch or so more of growth has been added, the plants are set in a bench six inches apart each way, but alternating in the rows. Plants in flats are watered with a fine sprinkler, and care is used against watering the young plants too freely, and the ventilation carefully attended to. For the plants in the bench the best practice seems to be to sprinkle for a week or so and then water between the rows with a full stream from the hose, and no spraying. A little care in the preparation of the soil will give an even distribution of the water. Watering thoroughly when needed seems to give better results than applying water too frequently. A thorough shallow stirring of the soil following the waterings, but not until the soil has ceased to be sticky, seems to be the best means of maintaining a good growing condition. The rot caused us but little trouble after the first cleaning up, and the only precautions taken were the painting of the pipes with a mixture of sulphur and oil, and the picking off of all unhealthy leaves.

The green flies were somewhat persistent in their attentions, but could always be subdued by thorough and (if necessary) repeated smoking. Occasionally, after a heavy smoking, the tips of some of the leaves seemed to be burned slightly, but this effect was not noticed when the smoking was done with more regularity.

Taking up now the crop of 1895—'96, already mentioned, we give in the following table the numbers by which the different blocks will be referred to and the character of the soil for each:

Blocks I and VIII are pure garden loam.

Blocks II and VII are ¾ garden loam † ¼ sand.
Blocks III and VI are ½ garden loam † ½ sand.
Blocks IV and V are ¼ garden loam † ¾ sand.

Block I is at the north end, over the beginning of the flow pipe of the heating system, and consequently is slightly warmer than the corresponding block at the south end. Each block contains space enough to accommodate 16 rows, of which 8 rows have 8 plants each and the others 7, making in all 120 plants per block.

During the season 8 plantings, comprising 5 varieties, were made. Each planting was carried the whole length of the bench, an equal number of plants (from 1 to 5 rows) being set in each block. Of these plantings, 2 showed the greatest yield for soil which was one-half sand, 2 for the soil which was one-fourth sand, and three for the pure loam.

The results obtained were somewhat confusing, until it was noted that the two plantings in which the soil containing one-half sand made the best showing were the earliest ones; that the plantings in which the soil containing one-fourth sand did the best were the ones next later, and that the plantings making the best showing for pure soil were the latest ones.

The yields from three lots of Denver Market set respectively December 16, December 28, and February 20, show this quite clearly, as do even more markedly those from two lots of Black-seeded Simpson planted December 28 and February 20. See the following table:

Number of the block, and kind of soil.	Barteldes's Denver Market. Average weight of heads, in grams.			Black-seeded Simpson. Average weight of heads, in grams.	
	Cut Feb. 8.	Cut Feb. 24.	Cut March 28.	Cut Feb. 20.	Cut March 30.
I.—Pure loam	35.90	62.37	**47.50**	48.79	**37.77**
II.—One-fourth sand	43.83	**72.52**	32.92	46.44	25.32
III.—One-half sand	**51.25**	59.53	23.12	**50.79**	17.03
IV.—Three-fourths sand	39.63	50.	25.65	49.20	19.39
V.—Three-fourths sand	40.06	52.70	21.93	41.03	17.44
VI.—One-half sand	**43.65**	63.17	34.93	**45.51**	35.87
VII.—One-fourth sand	33.33	**63.96**	47.00	45.73	58.50
VIII.—Pure loam	35.78	46.07	**54.57**	44.39	**76.00**

The above showing is quite in accord with the behavior of very sandy soils in general. The plant food such soils contain is quickly available, but is also soon exhausted, either by washing from the soil or by being taken up by plants.

On account of some irregularity in the time of cutting, it is impossible to make fair comparisons for all the varieties. Of two, however, the Denver Market and Black-seeded Simpson, there were lots with

practically corresponding dates of planting and cutting. For these the average weight per head for all the soils was: Denver Market 47.51 grams, and Black-seeded Simpson 40.55 grams. The other three varieties gave average weights per head as follows:

Grand Rapids Forcing..... 38.96 grams.
Tennis Ball..... 43.02
Tilton's White Star..... 43.11

The last two sorts are head lettuce, but in spite of their extra weights are inferior to the others for forcing.

In the winter of 1896-'97 both benches were set to lettuce.

The new east bench ,which stands from 1 to 2½ feet from the glass was filled 6 inches deep with forest-leaf mold mixed with one-fourth its volume of sand, while the west bench was cleaned out and refilled 5 inches deep with ordinary garden loam containing a like admixture of sand.

These benches were set from October 23 to December 28 with plants six weeks old from the seed of the following sorts: Barteldes's Denver Market, Black-seeded Simpson, and Grand Rapids Forcing.

The crop from both benches cut 60 days after the plants were set gave an average weight per head for—

East bench..... 31.84 grams.
West bench..... 31.11

In January an overhead coil of two wrought-iron two-inch pipes, 280 feet in all, or about 150 square feet of heating surface, was put into the house in order to test the merits of the two systems of heating, overhead and under-bench.

The water was kept shut off from the under-bench pipes, except on one or two occasions, so that for the second crop of lettuce the house was practically heated from above. This crop was cut about one meek younger than the preceding one. It showed an average weight per head for—

East bench..... 29.65 grams.
West bench..... 15.34

The following table gives the yield for the entire season, with a comparison of varieties:

Variety.	No. of heads.	Weight in grams.	Weight in pounds.	Weight per head (grams).
rteldes's Denver Market.....	884	25,927	57.6	29.32
ıck-seeded Simpson.....	1,648	39,454	87.7	23.94
ınd Rapids Forcing.....	768	21,796	48.4	28.38

In connection with this last crop, an experiment was made to learn whether or not the plants might be profitably set at greater intervals

than six inches. Plants were set at six inches apart each way and eight inches apart each may, in alternating four-foot blocks, with the following results:

For 32 square feet of bench plants 6 inches apart, 121 plants = 2,934 grams.
For 32 square feet of bench plants 8 inches apart, 66 plants = 2,267 grams.
Average weight of heads, plants set 6 inches apart = 24.24 grams.
Average weight of heads, plants set 8 inches apart = 34.34 grams.

With the exception of the experimental changes noted, the cultural methods followed have been essentially those outlined at the beginning of this paper.

One hundred days seems to be about the time necessary for the growth of a plant—six weeks in the flat, and eight weeks in the bench.

The lettuce raised has been of the finest quality, though the weight per head for any crop or variety has rarely exceeded 1½ ounces.

The results given are not at all a fair estimate of what might be achieved in a commercial way. Inferior soil, inferior varieties and wrong conditions have been used for the sake of experiment, and the bench space has not been at all times devoted to lettuce. The two benches will contain, when set at the usual distances (allowing three feet of space for ventilators), 2,000 plants $\left(\frac{2\times 64\times 4}{\frac{1}{4}} = 2{,}048\right)$. Taking 2½ ounces (70 grams), which was not at all an uncommon yield, under what seemed to be the proper conditions, as the average weight per head, we have 312½ pounds for a full crop. This can be repeated three times from November 25 to March 30, which is about the extent of the market season for this article. Lettuce sells readily here in bunches of three heads each for 45 cents per dozen bunches, which price gives $\left(\frac{2{,}000}{36}\times 45 \text{ cents} = \$25\right)$ for one crop, or $75 for the season.

The expenses connected with raising and disposing of a crop (judging from our experience, though of course our work has cost us more) can be kept close to $10, or $30 for the three crops. This is exclusive of the cost of heating, interest on the plant, etc., expenses which one manifestly could not afford to incur except in connection with a larger establishment, of which the lettuce business would be only a part. For the village market the product should not come on in three full crops at equal intervals of time, but rather in accordance with the demand and price.

For the first crop seed must be sown as early as the middle of August. Plants from this sowing, set late in September, will be ready for market about Thanksgiving time. Another setting should be made the last of October or the first of November, to be ready for the holidays; but usually the best market comes about the last of

February. For this reset the ground as fast as it is cleared for the holiday trade. Of course a succession of crops must be provided for all the intervening time. Later than March 31 hot-bed and cold-frame crops will be coming in; hence the last setting should not be later than the 1st of February.

FORCING TOMATOES. *(See Plate V.)*

The following account of an experiment in tomato forcing is of value rather as an indication of how readily the tomato lends itself to culture than as an example of the best methods of commercial tomato forcing:

Our Experiment-Station houses are of the kind described in the account of lettuce forcing, and do not afford either the room above the bench or the side light that have been found most favorable to getting a large crop of tomatoes from a given number of square feet of soil. In the house used for tomatoes the roof is only 7½ feet high at the ridge and 5 feet at the eaves; the glass is 10 × 14 inches, and lapped; the sash bars are 1 inch square, and in place of every third one comes a 1¾ × 3-inch rafter. Besides this there are ventilator fixtures and two lines of purlins to add to the shade. The provisions for heating are quite adequate. The piping is all four inch and under the benches, two flows on the west side and three returns on the east, 356 square feet in all, which kept up a night temperature varying from 50 to 60 deg., and an average daily maximum of 80 deg. The benches are 4 feet wide, with a 2½-foot walk between them, and stand 3½ feet above the walk and about 15 inches from the glass at the back side. A very good idea of the character of this house and the bench construction can be had from plate IV. The soil in the benches was prepared by putting in a 2-inch layer of well-rotted barnyard manure and 2 inches of garden loam, mixing them thoroughly, and then covering the mixture with a 2-inch layer of pure loam.

Seed for the crop was sown September, 15 in 2½-inch deep flats filled with loam and sand mixed in the proportion of 4 to 1. In three weeks the plants were taken from the flats and set in 2½-inch pots. These were twice repotted, the last time (November 19) into 4-inch pots, where they were allowed to stand until 8 or 10 inches high. Thirty uniform plants were selected of each of the following varieties: Dwarf Champion, Fordhook First, Royal Red, and New Stone. The plants were set in the benches December 10, each variety being separated into four lots, which were given different positions in the house in order to secure as nearly as possible a fair comparison of sorts. Two rows running lengthwise were put in each bench, the

rows 2 feet apart, and the plants 2 feet apart in the row. Plants in the front row stood 8 inches from the walk and were alternated with those in the back row in order to give the latter more light and make them easier cared for generally.

Training

The plants in the front row, where the soil was 33 inches from the glass, were trained to single stems and supported by 3-foot pieces of No. 6 wire stuck into the soil beside them. On the back row, with only 22 inches between the soil and the glass, 3 branches were carried up and tied to a wire running from rafter to rafter directly over the row. All the vines were further trained on a trellis of binding twine running from this wire to the ridge. After the main branches were established, the pruning consisted in cutting out the weak foliage, occasionally thinning the heaviest, pinching off suckers from the stem and keeping the walk open. Late in the spring, however, it was decided to end the crop by June 12, and on May 12 all branches except those bearing nearly full-sized fruits were cut off.

Watering.

While the plants were small (in flats or the first pots), the watering was done with a sprinkler. After they were set in the bench and until they began to bear the ground was well wet up twice a week by throwing a heavy spray from the hose. Later, the soil was soaked thoroughly every eight days, by flooding or running the water in broad, shallow trenches.

Cultivation.

After each watering, when the soil had dried sufficiently, it was cultivated lightly or leveled off. Toward the end of the season, however, no cultivation was given.

Pollination.

At first, the vines in bloom were tapped or shaken lightly each day to make the pollen fall upon the stigma, but this did not prove satisfactory, and for the nest two months the vines were gone over every two or three days, the pollen from newly open blossoms jarred into a small watch-glass, and then lifted and applied to the stigmas with the same instrument.* Late in March, artificial pollination was stopped. The fruits continued to set fairly, though not so well as before, until the drier, warm weather of late spring, when the blossoms fertilized themselves almost perfectly.

Diseases.

In the latter part of February brownish-colored decaying spots were noticed on the under side of a few green fruits. Specimens

*See Bullletin 28, page 52, Cornell Station, N. Y.

were sent to the Division of Vegetable Physiology and Pathology at Washington for examination, and the plants were given a spraying of Bordeaux mixture. The opinion received from Doctor Galloway was. that the rot was induced by some mechanical injury, or perhaps contact with water, the position of the spots suggesting that water from some source, possibly leakage from the snows which prevailed at that time, had gathered on the fruits, run to the lower side, and there collected in a drop. This trouble never became serious, though the spots were noticed occasionally afterwards during periods of considerable snow or rain.

Only one other disorder worthy of note made its appearance. This was the *œdema*, a physiological trouble brought about by the peculiar conditions to which plants are subject in forcing houses.

In Professor Atkinson's admirable description of this disease of the tomato* he gives the following summary of the symptoms of this disorder and of the conditions which tend to bring it on:

The *œdema* of the tomato is a swelling of certain parts of the plant, brought on by an excess of water, which stretches the cell walls, making them very thin and the cells very large. The excess of water may be so great that the cell walls break down, and that part of the plant dying exerts an injurious influence in the adjacent parts. The excess of water in the tissues is favored by the following conditions:

1. *Insufficient light.* The long nights of the early winter months, numerous cloudy days, and in part the walls and framing of the forcing house, deprive the plants of needed light. By a process known as *transpiration* plants are relieved of much water when well lighted, but in poor light, since the roots are absorbing water, it is apt to accumulate to excess. Well-lighted parts of the house, then, should be selected for the tomatoes.

2. *Too much water in the soil.* Water in excess can be withheld from the soil and prevent the trouble, and yet provide enough for the plants to grow.

3. *The temperature of the soil may be too near that of the air.* A high temperature of the soil makes the roots active, and if the temperature of the air is not considerably higher an excess of water is apt to accumulate in the plant. The aim would be, then, to have the temperature of the air considerably higher than that of the roots.

Lack of proper light also brings about the following harmful conditions:

1. *Acids in the plant accumulate in the dark, and in strong light they decrease.* When there is an abundance of water in the plant these acids draw large quantities into the cells, causing the cells to swell, resulting many times in *œdema*, or in the killing of the protoplasm, so that these parts of the plant die and become brown or black.

2. *Lack of light causes weak cell walls.* It is only when well lighted that plants are capable of making substances to build up cell walls with. Therefore, lack of light not only favors the accumulation of water, if other things are favorable, but it prevents the plants from building up strong tissues. In such cases plants can *grow themselves to death.* Possibly artificial light might be used to advantage.

*Cornell Bulletin No. 53. Geo. F. Atkinson.

A quiet and close atmosphere also favors the accumulation of water in the plant. Good ventilation should then be secured. Some means for the artificial agitation or exchange of air at night might probably be profitably devised.

Varieties of *tomatoes* more subject to *the œdema*. Those with a tendency to a very rapid and succulent growth are more liable to the trouble. Tomatoes which develop a firm, woody, young stem are less liable to it.

The conditions in our house at the time the disease appeared were just those indicated—induced by cold, cloudy weather outside, lack of light on account of snow and frost, and excessive heating of the bench soil by the under-bench pipes. The disease first appeared while the plants were still in pots and being watered frequently, and reached its worst in a few days. More ventilation was given, and the waterings were made less frequent. The *œdema* was checked, but not until almost every plant was more or less affected. Only the nearly healthy plants were set in the bench. These soon put forth plenty of healthy foliage, and seemed to recover their vigor completely; an occasional curled leaf could be found on the vines while the plantation lasted, but too rarely to make much difference. The times most favorable to their appearance were periods of cold and snow, when the air was naturally moist and considerable heat had to be kept up, without there being much chance for ventilation.

The conditions to be secured in preventing or checking this disease have already been suggested: They are, (1) as much light as possible; (2) free ventilation, so that it does not make the temperature too low; (3) careful watering, giving only enough for healthy growth of plants; (4) an increasing of the air temperatures above that of the soil, especially at night. Perhaps only one of these cautions need be attended to in some cases, and all are subject to limitations.

The Plants.

The vines have made a vigorous growth from the time they were set in the bench, and considerable quantities of foliage had to be removed to prevent their shutting out the light. Aside from the effect of the severe pruning on May 12, the vines are stronger now (June 15) than ever before, and the soil in the benches is filled with their roots. Shoots which started from near the base of the vines have grown two feet in the past month, showing how quickly and easily a renewal might be effected if there was need.

The date which we have taken to end the fruiting season is purely arbitrary, having no connection with the condition or habit of the plant. The tomato is a continuous bloomer, and its season need not end so long as the vines can be cared for and the fruit profitably disposed of.

The Fruits

Were perhaps some smaller than the outdoor grown, but still quite fair sized, many of them being three inches in diameter. For smoothness and symmetry they showed no inferiority, unless possibly the Royal Red had a slightly greater tendency to wrinkle than when it grows larger. Those from carefully pollinated flowers were noticeably larger and more full of seeds than the earliest and latest ones. This difference in size, however, might be due to some difference in cultivation or in the vigor of the vine. All the tomatoes seemed to be more firm and "meaty" than when grown out-of-doors.

On February 24, all varieties but Royal Red gave from one to three ripe fruits. No other difference in earliness was noticeable.

The total yield for the four varieties (120 vines), from February 24 to June 12 was 1,446 fruits, weighing altogether 279 pounds. The following table gives the yields by varieties:

Variety.	*No. of vines.*	*No. of fruits.*	*No. of pounds.*
New Stone	30	347	86.5
Fordhook First	30	398	66.5
Royal Red	30	303	[illegible]
Dwarf Champion	30	398	60.3

The yield from the rows closest the glass was the least, the two back rows (60 vines) giving 103 pounds, against 176 pounds from the front rows.

The time from the planting of the seeds till the first ripening of the fruits was 23 weeks. For about half of this time the plants grew in flats, which took up very little room. Since the crop was allowed to bear 3½ months, we may count in the necessary

Expenses.

Use and heating of house six months (according to locality).

Gathering fruit, 10 hours' work	$1 00
Watering, cultivating, etc., 25 hours	2 50
Cost of plants and setting	1 50

Our actual expenses were of course greater than this, for reasons which are obvious.

Receipts.

We made no attempt at selling high, but disposed of the entire crop, and without difficulty, at 12½ cents per pound. realizing thereby about $35 As winter tomatoes were a novelty to most people of this town, they were at first slow to buy, even at this price, but as they became familiar with them they sold readily, and doubtless a nice trade could be worked up where one cared to attempt tomato forcing in a commercial way.

As tomatoes yield directly in proportion to the expanse of vine surface they can be given, with due regard to light and air, a house

of the same bench room as ours, but higher, with the benches set lower or the plants bedded in soil directly on the bottom of the house, and heated by pipes carried around the sides of the house, could be made to produce a much heavier crop with the same outlay for care and but little additional heat.

Plate V is from a photograph of the house taken during the period of best yield.