Studies Of

Plant Production Methods For Vegetable Crops

Cabbage - Tomatoes - Onions Melons and Cucumbers

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Most home gardeners, and some commercial vegetable growers, depend on other persons for plants of crops such as cabbage, tomatoes and onions. Gardeners know that the quality of the plants they set out materially affects the yield they secure, and especially the important early-season yield. Therefore there has been need for information on how quality of plants is affected by the way they are grown and marketed.

Also, it has been suggested that use of transplants might have value for crops such as cucumbers and melons which now are usually started by direct seeding in the field. It appeared that transplanting might avoid difficulties due to slow germination, seed rotting, destruction of seed by rodents, and damage to small seedlings by cucumber beetles.

Experiments aimed at developing more information on these subjects was conducted by the Experiment Station for several years at three locations: the Main Station at Stillwater, the Vegetable Research Station at Bixby, and the Kiamichi Field Station at Idabel. This bulletin reports results of that research.

The work reported here points to these conclusions:

Cabbage

● Cabbage plants grown in a greenhouse in Oklahoma produced more than twice as much total yield, and more than four times as much early yield, as field grown plants shipped in from further south.

● Cabbage plants grown in plant bands made higher early and total yields than those grown in flats; but the gain probably was not enough to warrant the extra cost of growing and setting the plants.

● Cabbage plants grown in a hotbed were superior to those grown in a coldframe. Good plants were grown by the coldframe method; but for commercial production the hotbeds appear to have an advantage (See page 8).

Tomatoes

● Tomato plants grown in a greenhouse in Oklahoma produced about 50 percent more total yield than field grown plants from further south, and the crop was matured several days earlier.

● Tomato yields are likely to be definitely reduced if less than four square inches of bed space is allowed per plant. Plants grown in flats and bands are about equal in quality, provided a block of soil is retained on the roots when transplanting.

● Size of container was more important than type of container when growing tomatoes in bands or pots. Both yield and early production increased as the size of the container increased.

● Combinations of space per plant and different periods of time from seeding to transplanting were not studied. However, it appears likely that a 3x3-inch or 4x4-inch spacing would be used to better advantage if plants were started eight to ten weeks ahead of the time for setting in the field. The 2x2-inch spacing was generally adequate for the 6-weeks period used for growing tomato plants in this test.

Onions

● Southern field grown onion plants were more productive than those grown in Oklahoma in a coldframe.

Melons and Cucumbers

● Melons and cucumbers can be started in a greenhouse in veneer bands and transplanted to the field. This method avoids losses due to seed rotting, destruction of seed by rodents, or damage to seedlings by cucumber beetles. Harvest from such transplants was about two weeks earlier.

Cabbage

SOUTHERN FIELD GROWN

vs

LOCAL GREENHOUSE PLANTS

Test plantings were made for three years to compare southern field grown plants with plants grown in flats in the A. & M. greenhouse at Stillwater. The seed for the greenhouse grown plants was planted January 25, and the seedlings transplanted into flats at a 2x2-inch spacing approximately a week later. The flats of plants were moved to a coldframe about a week previous to field setting in order to harden them. The field grown plants were secured directly from a commercial plant farm in eastern Texas, and the plants were set out within 12 hours after being received. All plants were set in the field during the last week of March. The flats of plants were taken to the field, and the plants removed in such a manner as to retain a block of soil on each plant. All plants were set in the field by hand.

Yield and time of harvest data secured from these tests are summarized in Table I. It is apparent that the greenhouse grown plants were much more productive, and they matured considerably earlier.

TABLE I.—Production and Time of Harvest of Cabbage from Southern Field-grown and Greenhouse-grown Plants.

Year	Percent of crop harvested by:		Pct. of plants producing heads	Avg. weight of heads (lbs.)	Total yields (tons per acre)
	June 3	June 15			
	Southern Field Grown Plants				
1942	6.0	36.1	73.5	1.78	6.51
1943	7.3	61.7	24.5	1.29	1.55
1944	27.6	75.9	65.1	1.92	6.18
Average	13.7	57.9	54.4	1.66	4.75
	Greenhouse Grown Plants				
1942	66.7	94.1	94.2	2.23	10.14
1943	48.7	91.1	87.5	1.98	8.40
1944	65.4	98.2	97.9	2.91	13.77
Average	60.3	94.5	93.2	2.37	10.77

The field grown plants required approximately two weeks more time to develop to the same stage of maturity.

SPACING IN FLATS AND USE OF VENEER BANDS

The effect of two different plant spacings was compared with the use of wood veneer bands during the years 1945 and 1946. In addition, two different spacings in a coldframe were tested. Plants in the cold frames grew exceptionally fast during November 1945, because of mild temperatures and adequate moisture. By March, these plants were developing seed stalks and were not transplanted to the field.

The results of this work are summarized in Table II. Little difference in yield was found except that the plants grown in bands were definitely higher in both early yield and total yield. It is doubtful however, that use of plant bands for growing cabbage plants would be commercially feasible. The cost of bands and extra labor required for transplanting seedlings into bands and then to remove the bands when the plants are set in the field amounts to approximately $75 for 10,000 plants, the number required to set an acre.

HOTBED vs COLDFRAME

The production in 1946 from plants grown in a coldframe indicated that quality plants could be produced by that method. There-

TABLE II.—Production of Cabbage from Plants Grown in Various Ways.
(Pounds per acre)

Year	In greenhouse			In coldframe	
	In Flats		In 2x2 in. plant bands	Spaced 1x4 in.	Spaced 2x2 in.
	Spaced 1½x1½ in.	Spaced 2x2 in.			
	Early Yield				
1945	3462	4551	5358	-----	-----
1946	3444	3283	6178	5138	4073
Average	3453	3917	5768	-----	-----
	Total Yield				
1945	12670	13356	14252	-----	-----
1946	12383	12164	15946	13761	12285
Average	12526	12760	15099	-----	-----

TABLE III.—Comparative Yields from Cabbage Plants Grown in Hotbeds and Coldframes.
(Tons per acre)

Year	Hotbed Grown	Coldframe Grown
1948	5.06	1.70
1949	3.82	2.37
1950	7.94	7.94
1951	7.61	6.03
1952	8.60	7.12
Avg.	6.61	5.01

fore during five following seasons plants grown in a coldframe at the Kiamichi Field Station, Idabel, were compared with those grown in a hotbed at the Vegetable Research Station at Bixby. An equal number of plants from each source was used in experimental rotation plots at Bixby.

The production figures in Table III show the superior quality of the hotbed grown plants in four of the five years. Although good plants can be grown by the coldframe method, the additional three months of growing time greatly increases the chance that something may happen to cause serious loss. The cost of heating the hotbeds for six weeks is more than offset by the shorter time the beds must be cared for, and by the increased early and total production.

The major difficulty encountered in growing plants in coldframes at Idabel was damage due to night temperatures falling considerably below those predicted or expected. An appreciable loss of plants resulted from freezing in three of the five years.

Tomatoes

SOUTHERN FIELD GROWN

vs

LOCAL GREENHOUSE PLANTS*

Southern field grown tomato plants were compared with those grown in the A. & M. greenhouse at Stillwater during three years. The greenhouse plants were grown in the same manner as described

* This portion of the research was done by Dr. H. B. Cordner.

for cabbage plants, except that the time of planting was approximately four weeks later.

Loss of plants after transplanting into the field was a major problem with the field grown plants. Average production for the three crops was 7.89 tons per acre from the greenhouse grown plants and 5.23 tons per acre from the southern field grown plants. Production from the field grown plants was actually less than 5.53 tons, but yields were corrected somewhat on the basis of plant stand.

The greenhouse grown plants were several days earlier in maturity, in addition to being 50 percent higher in total yields.

METHODS OF PRODUCING PLANTS

The superiority of the locally grown plants in the foregoing test led to a 3-year series of trials aimed at obtaining information on the most desirable method or methods of growing tomato plants.

Age of Plants When Set in Field

The effect of age of plants when set in the field was tested by varying the seeding dates to provide periods of four, six, and eight weeks for plant growth before field planting on April 20. The plants were grown in flats by transplanting the seedlings at a 2x2-inch spacing.

Results are given in Part A of Table IV. The four-week age treatment was omitted the third year because of the relatively poor results obtained the first two years. Although the eight-week-old plants were most productive for the 3-year period, the six-weeks-old plants were at least equal in performance two out of the three years.

Spacing of Plants in Flats

Seeded in Flats

A high percentage of the tomato plants grown in Oklahoma are seeded directly into flats or beds and then pulled out of the soil when sold or transplanted to the field. As a rule, the plants are crowded to the extent that only about one square inch of space is allowed for each plant. To determine the effect of plant spacing under this method of growing, the stand of plants in flats was thinned to provide one, two and four square inches per plant. Results from two years of testing are given in Part B of Table IV. It is apparent that, within the range used in these tests, the amount of space allowed plants in the seed bed has a direct effect on production.

Transplanted to Flats

The effect of plant spacing in flats was also tested using plants transplanted to flats while in the seedling stage. When the plants used in this test were set in the field, an effort was made to retain on the roots of each plant a block of soil equal to the plant spacing in the flats.

Results of this test are given in Part C of Table IV. Relative yields during the second year are probably more in line with what might be expected than are those obtained during the first year. The soil used in the flats the first year was too friable and crumbled apart

TABLE IV.—Results of Tests of Various Methods of Growing Tomato Plants.
(Yields in pounds per plant)

	1946	1947	1948	Avg.
A. Age of Plants When Set in Field.				
8 weeks	6.5	5.2	4.0	5.3
6 weeks	6.8	3.5	4.0	4.6
4 weeks	5.6	1.8	---	3.7
B. Seeded Directly in Flats; Thinned in Various Spacings.				
½ x 2	5.6	3.0	---	4.3
1 x 2	6.9	3.2	---	5.0
2 x 2	7.5	5.5	---	6.5
C. Seedlings Transplanted to Flats at Various Spacings.				
1½ x 1½	7.3	3.6	---	5.5
2 x 2	8.7	3.8	---	7.3
3 x 3	6.0	5.6	---	5.8
4 x 4	7.7	6.7	---	7.2
D. Seeds Spot Planted vs. Seedlings Transplanted (2x2-inch spacing).				
Spot seeded:				
2 x 2 in. flats	7.5	5.5	4.5	5.8
2 x 2 in. bands	7.4	6.2	3.5	5.7
Transplanted:				
2 x 2 in. flats	8.7	3.8	4.0	5.5
2 x 2 in. bands	7.7	6.8	4.0	6.2

when an attempt was made to handle the plants spaced 3x3 and 4x4 inches. Soil on the roots of plants grown at the 1½x1½- and 2x2-inch spacings was undisturbed. The check in growth when the plants grown at the greater spacings were set in the field probably accounts for the relatively low yields from those plants.

Spot-seeding in Flats

vs

Transplanting Seedlings

For some plant growers, it may be more convenient to spot-plant two or three seeds at each location where a plant is wanted and then remove the extra seedlings than it would be to start seedlings planted thickly in specially-prepared soil or other medium (such as vermiculite) and then transplant the seedlings to flats. Therefore these two methods were compared in flats and also in wood veneer bands.

Results are shown in Part D of Table IV. In the bands, the transplanted plants were consistently more productive, though the difference was never large. In the flats, there was no consistent difference between the two methods.

Flats vs Veneer Bands at Same Spacing

Table IV also permits comparison between plants grown in plant bands and those grown in flats at the same spacing. No consistent difference was found. In this test, a block of soil approximately 2x2 inches was carefully retained on the roots when each plant from the flats was set in the field. If plants had been pulled from the flats without retaining a block of soil on the roots, the results would, of course, have been much different.

Types of Individual Plant Containers

Individual containers of various types and sizes were tested during three years. Plant bands of wood veneer, manila paper, and heavy asphalt paper of sizes 2x2x3, 3x3x3, and 4x4x3 inches were used. Standard clay flower pots of 3- and 4-inch sizes were used one year. There were no consistent differences in production from plants grown in the various kinds of containers of equal size. The light weight paper bands were more difficult to handle because of the flexible quality of the paper; and, by the time for field setting of the plants, the bands had practically disintegrated.

Yield increases were secured as the size of the containers was increased. Average production per plant was 7.1 lbs. from the plants grown in 2x2-inch containers, 7.9 lbs. from the 3x3-inch size, and 8.4 lbs. from the 4-inch. Early production secured was 1.57, 2.01 and 2.30 lbs., respectively. This compares favorably with the one pound or less from plants grown in flats at ½x2- or 1x2-inches.

Onions

SOUTHERN FIELD GROWN

vs

LOCAL COLDFRAME PLANTS

Onion plants of the Yellow Sweet Spanish variety were grown by planting seed in coldframes in October at the Kiamichi Field Station, Idabel. Plants grown from the same lot of seed by a commercial plant farm in Texas were secured for comparative performance. The plants were set out in experimental plots at the Vegetable Research Station, Bixby. The annual yields secured during the 3-year trial were as follows:

From plants grown in coldframes: 187, 292 and 298 bushels per acre; averaging 292 bushels per acre.
From Texas field grown plants: 309, 407, and 444; averaging 387 bushels per acre.

The plants grown in coldframes were smaller at transplanting time; and in two of the three years they had been somewhat injured by freezing while still in the frames.

Melons and Cucumbers

Methods of getting early stands of melons and cucumbers were tested in the four years 1944-1947. Muskmelons grown in the greenhouse in wood veneer bands and then transplanted to the field were compared with those seeded directly in the field. The same methods were compared for watermelons and cucumbers; and, in addition, these crops were also started under hotcaps and by direct field planting of pre-sprouted seed. (The pre-sprouted seed were planted when germination was just starting.)

With muskmelons, the annual yields were:
From direct seeding: 7,859, 4,074, 2,419, and 7,378 pounds per acre; averaging 5,433 pounds per acre.

From transplants: 11,654, 4,690, 6,242, and 12,894 pounds per acre; averaging 8,870 pounds per acre.

The harvest season was approximately two weeks earlier from the transplanted plants.

Results with watermelons and cucumbers varied considerably from year to year, depending upon how favorable the seasonal conditions were for germination and early growth of the seed planted directly in the field without pre-sprouting.

The work with melons and cucumbers clearly indicated the feasibility of starting plants of these crops in pots or bands. For a very early crop the seed can be planted in the containers about two weeks ahead of the time for planting in the field, thus having plants to set out instead of planting seed. The transplanting method could be used as an emergency in the event soil and weather conditions at planting time were unfavorable. Seed could be planted in containers and the plants set in the field two weeks later, in this way avoiding a delayed harvest due to late planting.