THE INFLUENCE OF TRANSPLANTING DEPTH OF HEAD LETTUCE ON SIZE AND SHAPE OF HEAD

by

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INTRODUCTION

Lettuce (Lactuca sativa L.) is the most important salad plant and one of the highest money value vegetable crops of the United States. The commercial lettuce grown consists mainly of a few highly selected varieties of the crisp-head type. Most of the commercial head lettuce is produced in the cool, irrigated districts of some of the Western States and certain favorably located sections of the East. Head lettuce is shipped from the West throughout the year, and in the East it is grown mainly as a spring crop. The Western States produce approximately 85 percent of the commercial crop, with California producing approximately two-thirds of the total production of the country. Most of the head lettuce produced in the West is shipped to the Eastern markets.

The East should produce more of the head lettuce consumed in the East because it would increase the income of the Eastern growers. Eastern grown head lettuce is not as uniform in quality as the Western grown head lettuce due to poor climatic conditions such as insufficient moisture, high summer temperatures, and improper fertility levels. Cultural practices also influence the quality of Eastern grown head lettuce. In most of the lettuce growing areas of the East it is necessary to start the plants in protected beds or greenhouses and transplant them at least once before setting them into the field. These practices are necessary so the crop will mature before hot weather.

Experimental workers and growers of head lettuce have observed that the manner in which lettuce plants are transplanted into the field influences the

size and shape of heads. Their belief is that the deeper the plants are set in the field when transplanting, the smaller and more conical the heads. The author has observed this difference in size and shape of heads in commercial plantings.

The objective of this investigation was to determine if the depth of transplanting causes a significant difference in size and shape of head in crisp-head lettuce.

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REVIEW OF LITERATURE

Investigation into most sources of literature has revealed no previous experimental work published on this particular problem. Personal correspondence with several leading experimental workers who recognize the existence of this problem has revealed no knowledge of existing experimental work dealing with this problem.

Thompson (5) states that too deep transplanting will ruin head lettuce. Shoemaker (3) states that deep transplanting of head lettuce results in more elongated heads than normal. Thompson (6) states in personal correspondence, "I am well convinced that deep setting tends to produce heads that are more conical than shallow planting. All conical shaped heads are not necessarily due to deep setting but a great deal of it is due to this factor. I believe one can show other effects on growth and head morphology that can be attributed to transplanting techniques." Personal correspondence with Professor Charles J. Noll (2) at Pennsylvania State College has brought out the fact that field men working in the head lettuce experimental plantings at Pennsylvania State College are instructed not to ridge the lettuce rows with mechanical cultivators nor pull dirt into the rows by hoeing because young lettuce plants partly covered with dirt produce distorted heads.

All of the experimental workers contacted are convinced that depth of transplanting does influence the size and shape of head on lettuce. They are also interested in seeing experimental work done on this problem. All information concerning practices which will increase the uniformity of head lettuce will be of value to the commercial growers.

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EXPERIMENTAL PROCEDURE

Three experiments were conducted under different growing conditions, (1) in a hotbed, (2) in the greenhouse, (3) in the field. The field plot was the one intended to give the most information because commercial practices were followed.

Variety

A select strain of Imperial 44 seed was used. The source of the seed was the United States Department of Agriculture Trial Station in San Jose, California. Imperial 44 has proven to be one of the better adapted varieties of crisp-head lettuce in the East because of its tolerance to high atmospheric temperatures and variable soil conditions in the East. It is a uniform heading variety of medium size. Imperial 44 was developed by the United States Department of Agriculture in cooperation with the New York (Cornell) Agricultural Experiment Station for Eastern growing conditions, particularly the muck lands of New York. Beckenbach, Jamison, Ruprecht, and Andrews (1) state that Imperial 44 has become one of the leading varieties in the East on many types of soil and is grown extensively in Florida.

The same variety and seed lot was used for all three experiments to eliminate any differences that might occur between seed lots or varieties.

Planting of Seed and Spacing of Plants

Seeds for each experiment were planted in one seed flat in rows three inches apart running the long way of the flat. The soil used was a 50:50 mixture of silt loam soil and sand which had been steam sterilized. The

seed were covered lightly with the same soil that is described above. The flat was covered with a piece of unbleached muslin and watered until the soil was saturated. The cloth was removed when the plants began to emerge.

When the plants were approximately two weeks old and had two or three true leaves which made them large enough to handle with ease they were transplanted into Bird-10 Vita-Bands, 1 1/2 inches by 1 1/2 inches in size. The bands were placed in flats and filled with soil from the plot where the plants were to be grown to maturity.

The soil that was in the bands was left on the roots when the plants were later transplanted to their permanent location. Occasionally, a small amount of the soil around the top of the band had to be removed so that a uniform depth could be maintained. The bands were torn and carefully removed before the plants were set into the soil.

Size of Plants Used

Plants of a uniform size were selected for use in the transplanting experiment. The plants selected were approximately four inches tall. This necessitated the growing of a surplus of plants in the bands so that this selection could be made. The selection of plants of a uniform size reduced the likelihood of variation between plants in each treatment.

Transplanting Depths

Three transplanting depths were used, shallow, medium, and deep.

For the shallow transplanting depth the plants were placed so that the roots were completely in the soil, but the crown area or hypocotyl was completely above the soil level. Little mechanical support was furnished the plants by the roots or stems until the plants were established. These plants fell over when transplanted.

For the medium transplanting depth the plants were set so that their roots were well covered by the soil. The outside leaves which are the oldest true leaves were barely above the soil level. The hypocotyl area and part of the stem below the leaves were covered with soil. At this depth the plants received some mechanical support which prevented them from falling over after being transplanted.

For the deep transplanting depth the plants were placed at a depth so that the roots, hypocotyl area, stems, and part of the outside true leaves were covered in the soil. The terminal growing point was kept barely above the soil. At this stage of development the leaves all grew upright and the terminal growing point was inside the rosette of true leaves.

Experimental Plots

Hotbed Experiment

The first experiment was conducted in an electrically heated hotbed located on the Virginia Polytechnic Institute campus. The hotbed was 5 feet 10 inches wide and 36 feet long. The hotbed was located on a slope where the lower side of the bed faced toward the southeast. A mixture of approximately 50:50 well rotted compost and silt loam soil was used to fill the hotbed. The soil analysis found in table 1 showed the soil was high in fertility and pH so that no commercial fertilizer or lime was needed.

The seed were planted in a flat on November 13, 1950. The seedlings were pricked out into bands on December 1, 1950. The plants were transplanted from the bands into the hotbed at the desired transplanting depths on January 2, 1951.

The plants were spaced 15 inches apart in the rows and 15 inches between rows. A guard row was set completely around the bed at the same spacing

as the plants within the experiment. Five rows ran the length of the hotbed, the three inside rows being the ones used for the three depth treatments. The three rows were divided into three replicates and the treatments were randomized in each replicate. Eight plants were used in each treatment and 24 plants in each replicate. The close spacing and small number of plants in each treatment as well as only three replicates was necessary to fit the experiment to the hotbed.

Some damage was done by pests of different types. Ground moles uprooted some of the plants before they were controlled by the use of Cynagas in their tunnels. Some of the plants were destroyed by Drop or Sclerotiniose caused by the fungi (Sclerotinia sclerotiorium Lib. or S. minor Jagger). An early application of fungicide spray of "Terasan" controlled the disease only after some damage had been done. An infestation of green aphids at the end of the growing season was controlled with three sprays of nicotine sulfate.

The first cutting of matured heads was made March 23, 1951. The second and final harvest was made March 27, 1951. The weight of the total plant harvested and the measurements of width, height, and core length were taken as each head was harvested.

The daily temperature and weather conditions were closely observed for the hotbed experiment because it was conducted during the winter and early spring. The hotbed sashes had to be opened on days when the temperature was above 32° F. The heating units were thermostatically controlled to maintain the temperature of the hotbed above 40° F. The heating units were not effective in maintaining the temperature above 40° F. when the outside temperature was below 5° F. The temperature only dropped below this critical

temperature twice and the heating units maintained the hotbed temperature above freezing both times.

Greenhouse Experiment

The second experiment, which was a modification of the hotbed experiment, was conducted in the Virginia Polytechnic Institute greenhouses. The experimental plot was in a ground bed 11 feet wide and 21 feet long. The bed was excavated twenty inches deep and a layer of crushed rock six inches deep was placed in the bottom to provide drainage. The bed was then filled with a greenhouse soil mixture consisting of two parts sand, three parts well rotted compost (leaves, straw, and stable manure) and five parts of a silt loam soil. The bed had sides six inches higher than the walk level. The bed was filled with soil to within four inches of the top of the side walls. The soil was watered thoroughly for two weeks before any plants were set in it to allow for any settling of the soil in the bed. No commercial fertilizer or lime was used on this soil because the soil analysis (table 1) showed a high state of fertility and a high pH.

The seed for the greenhouse experiment were planted in a seed flat January 18, 1951, and the seedlings were pricked out into bands February 9, 1951. The plants were transplanted into the greenhouse ground bed at the desired transplanting depths March 14, 1951.

The plants were spaced 17 inches apart in the row and 18 inches between rows. Each treatment consisted of a single row of 10 plants. A randomized block design was used with three treatments replicated four times. A guard row was planted completely around the four replicated at the same spacing as was used within the experiment. This spacing was more nearly the desired

spacing for head lettuce than that used in the hotbed but was not great enough for the best growing conditions.

An early infestation of aphids was controlled with three applications of nicotine sulfate and one application of parathion. Some Drop was observed in the early stages which was controlled by three applications of "Terasan" fungicide.

All of the plants in the greenhouse experiment bolted to seed before any heads were formed so that no data was collected. This bolting was caused by excessively high temperatures during the growing season. The high temperatures could not be lowered by ventilation when the outside temperature reached 70° F. or higher.

Field Experiment

The third experiment was conducted in the field located near the greenhouse. The plot area was a relatively level, well drained Groseclose silt loam of average fertility. The results of the soil analysis will be found in table 1. Two applications of a 5-10-5 complete fertilizer were used to grow the crop. The first application, which was at the rate of 1500 pounds per acre, was applied broadcast one week before setting the plants and was raked in with a garden rake. An application was made when the plants were half grown, which was 40 days after they were set in the field. This application was at the rate of 750 pounds to the acre broadcast on the surface as a top dressing and worked into the soil with a hoe.

The seed for the field experiment were planted in one flat April 4, 1951. The seedlings were pricked out into bands April 20, 1951. The plants were grown in the greenhouse until they were transplanted into the field on May 1, 1951.

The field experiment was large enough to be able to have the proper spacing and a sufficient number of plants to collect valid data. Each treatment consisted of a single row of 10 plants. A randomized block design was used with three treatments replicated four times. The plants were spaced 18 inches between plants and 18 inches between rows. A guard row was planted completely around the four replicates and the plants in the guard row were transplanted shallow for observational purposes.

There were no pest control measures taken because the plants were free of insects and diseases.

The first harvest of matured heads was made June 18, 1951. The second harvest of matured heads was made June 20, 1951. The third and final harvest of matured heads was made June 23, 1951.

Harvesting and Sampling Procedure

All heads of lettuce were harvested in the early morning. Maturity was determined by the application of a firm pressure on the head with the thumb and fingers. If the head felt solid and did not yield to this pressure, it was harvested. When heads were mature and ready for harvest they were solid and the tops of the heads had a light-yellowish color.

All sampling data were taken on each head as it was harvested. A sharp knife was used and the head was harvested by cutting the stem at the soil level. Each head was then weighed before any wrapper leaves were removed. The weight was recorded in ounces. Each head was then inverted and dissected through the center from the base of the core to the top of the head so that the head and the core was cut in half. The width of the head was measured in inches from one side of the head to the other at the widest

point. The length of the head was measured in inches from the lower end of the stem to the highest point of the top of the head. The core length was measured from the cut end to the apical end. All measurements were taken to one hundredth of an inch.

The data were analyzed by the analysis of variance. The calculated variance was compared at the 5 percent and the 1 percent levels.

Table 1.--Results of soil tests from hotbed, greenhouse, and field experiment.*

	Hotbed		Greenhouse		Field Plot	
	Symbol**	Lbs./Acre	Symbol**	Lbs./Acre	Symbol**	Lbs./Acre
Calcium	V G	1500+	V G	1500+	F+	500
Magnesium	V G	1500+	V G	1500+	F	250
Phosphoric Acid	F	96	F+	138	G	180
Potash	V G	250+	V G	250+	F-	64
Organic Matter	4.8%		3.6%		1.3%	
pH	7.0		6.9		6.5	

* Each sample was a composite of nine borings at a depth of five inches in hotbed, eight inches in greenhouse, and ten inches in field.

** V G = Very Good
G = Good
F = Fair

SHALLOW MEDIUM DEEP

Figure 1.--Disected heads of lettuce representative of three transplanting depths in the field experiment.

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PRESENTATION OF RESULTS

Hotbed Experiment

The data collected from the hotbed experiment were incomplete because of missing plants in all replicates. The hotbed experiment was used primarily as a preliminary experiment to work out transplanting techniques. The information gained was used in conducting the greenhouse and field experiments.

The analysis of variance showed no significant difference between any of the three transplanting depths for weight, height, width, and core length. The summary of variance will be found in table 2.

Greenhouse Experiment

No useable data were secured from the greenhouse experiment because the plants bolted to seed before heading. Bolting was caused by excessively high temperatures (80° to 90° F.) during the latter part of the growing season. The temperature in the greenhouse could not be controlled on bright days when the outside temperature exceeded 70° F. This experiment was of value in giving practice in the transplanting technique. Close observation of the plants gave information of value in the differences in growth between transplanting depths. These observations showed that in the early growth of the lettuce plants there was a difference in the type of growth between the three transplanting depths. The shallow transplanted plants appeared to be larger and grew faster in the early stages of growth than the medium or the deep treatments. The deep transplanted plants were more upright in their growth and the leaves were smaller and more curled than the other two treatments.

Field Experiment

The field experiment proved to be quite successful in supplying the necessary data to determine the influence of depth of transplanting on size and shape of head. The growing conditions were good and there was sufficient moisture to produce the crop. There was no damage from insects or diseases and all plants set in the experiment were harvested as fully matured heads. There were no bolted heads and every head harvested was marketable. The data collected from this experiment are presented in the index. The mean weight, height, width, and core length are presented in table 3 along with an index of height divided by width.

Weight of Heads

The statistical analysis showed there was no significant difference in weight of heads between treatments. The summary of variance for weight of heads is shown in table 4. The heads from the shallow transplanting depth were larger in total volume than the heads from the medium to deep transplanting depths. That the heads weighed the same indicates that the heads from the shallow treatment were not as firm as those from the medium and deep treatments. Figure 1 shows this difference in firmness and compactness of heads between treatments.

Width of Heads

The data presented in table 3 show very pronounced differences in width of heads between the three transplanting depths. The heads harvested from the shallow transplanting depth were of normal width and shape for Imperial 44, as described by Thompson (4). Heads harvested from the medium transplanting depth were more conical and not as wide as the heads from the shallow

transplanting depth. The heads from the deep transplanting depth were more conical than those from the medium transplanting depth. The summary of variance (table 4) shows that the differences in width are highly significant between treatments. The ratio of height divided by width (table 3) gives a direct measure of the variation in shape which resulted from the differences between transplanting depths.

Height of Heads

The heads harvested from the three transplanting depths were all the same height. Summary of variance (table 4) shows no significant difference in weight among transplanting depths. Since there was no difference in height of heads among transplanting depths, the index of height of heads divided by width was more accurate in measuring shape of head. The table of means showed a difference of only 0.229 inches in height between transplanting depths of shallow and deep but a difference of 1.195 inches in width.

Core Length

The core length was found to be significantly different among transplanting depths. This difference is illustrated in figure 1. The analysis of variance (table 4) also shows a significant difference in core length among treatments only at the 5 percent level. The mean differences in core length shown in table 3 gives an indication there would be less waste in the deep treated heads than the shallow or medium treated because of the small core.

Shape of Leaves and Heads

In addition to being more conical the heads from plants subjected to the deep transplanting depth were slightly flattened on two sides. The leaves

Table 2.--Analysis of variance for weight, height, width, and core length of heads of lettuce grown in the hotbed and subjected to three transplanting depths.*

	D. F.	Core Length M. S.	Width M. S.	Height M. S.	Weight M. S.
Replicates	2				
Treatment	2	0.0125	0.5625	0.2900	4.730
Experimental Error	4	1.0810	0.2775	0.2090	1.986
Sampling Error	47	0.3965	0.4427	0.2506	10.083
Total	55				

* No significant differences between treatments.

were tightly curled within the head of the deep transplanted plants so that it was impossible to remove a leaf intact from within the head. The leaves of the medium transplanted heads were curled somewhat but were not as compact within the head as the deep treated. The heads from plants transplanted shallow were larger and only slightly curled which is typical of Imperial 44. The leaves could be removed from the head intact which is a desirable characteristic. All of these differences described are illustrated in figure 1.

Maturity Date

The heads from the deep transplanting treatment were earlier in maturing than either of the other treatments. At the first harvest only 20 heads out of 40 to be harvested were cut in the shallow transplanting depth. There were 25 out of 40 heads harvested from the medium transplanting depth at the first harvest. For the deep transplanting depth there were 27 out of 40 heads harvested at the first harvest and the remainder were harvested two days later. Two more harvests were necessary to complete the harvest of the medium and shallow transplanted plants. Sufficient data were not available for statistical analysis, however it shows a trend in maturity date between transplanting depths. Even with the difference in maturity date there was no difference in the weight of the whole plant harvested between transplanting depths.

Rubber Band Pressure Treatment

There is an indication the mechanical pressure of the soil influences the size and shape of heads. To try to prove the theory of mechanical pressure, a side experiment was conducted on six plants in the guard row. These plants were transplanted into the field at a shallow depth so that this test could be conducted. Each of the six plants were bound with a rubber

Table 3.—Mean weight, height, width, and core length of heads of lettuce grown in the field and subjected to three transplanting depths.

Transplanting Depth	Weight in Ounces	Height in Inches	Width in Inches	Core Length in Inches	Height Divided by Width
Shallow	20.58	5.262	4.886	1.572	1.076
Medium	20.72	5.491	4.650	1.470	1.181
Deep	18.95	5.325	3.691	1.228	1.444
L.S.D.: .05 Level .01 Level	N. S.	N. S.	.323 .489	.222 .337	

band at approximately the same area at which the deep transplanted plants were covered in the soil. A rubber budding band one-eighth inch wide and six inches long was used. The band was wrapped around the plant as soon as it was well established in the field. The bands were left on the plants until they were harvested. These plants showed the same general growth and heading characteristics as the deep transplanted plants. These characteristics were not as extreme as the deep transplanted plants. The ratio of height divided by width for the rubber band treated was 1.28 against the deep treatment which was 1.44 and the medium treated which was 1.16. This observation tends to substantiate the theory that the mechanical pressure of the soil influenced the type of growth observed on the deep transplanted plants. It also brings out the trend in degree of distortion from the medium treatment to the rubber band treatment to the deep treatment.

Table 4.--Analysis of variance for weight, height, width, and core length of heads of lettuce grown in the field and subjected to three transplanting depths.

	D. F.	Core Length M. S.	Width M. S.	Height M. S.	Weight M. S.
Replicates	3				
Treatment	2	1.2556*	16.0203**	0.5591NS	33.7583NS
Experimental Error	6	0.1657	0.3482	0.3996	15.3028
Sampling Error	108	0.0797	0.3161	0.2190	8.3796
Total	119				

* Significant at .05 level.
** Significant at .01 level.

VII

DISCUSSION OF RESULTS

Hotbed Experiment

The analysis of variance for the data collected from the hotbed experiment showed no significant difference in size and shape of head among transplanting depths. The reasons for there being no meaningful difference between treatments may have been influenced by the small number of plants available for collection of data. This is reflected in the high sampling error observed in table 2. The high fertility of the hotbed soil influenced the plants to grow very rank, which may have contributed to the lack of difference in size and shape of head. The soil was very high in organic matter which made it loose and friable. The soil probably did not furnish sufficient mechanical pressure on the deep transplanted plants to influence them to be more distorted than the shallow or medium treated. Lettuce grown in peat and high organic soils may not be as inclined to produce distorted heads as readily as if planted in low organic soils.

Greenhouse Experiment

A trend in tendency to bolt more slowly was observed in the greenhouse for the deep transplanted plants. This tendency may not be significant. However, the compactness of head associated with deep transplanting may influence the bolting tendency.

Field Experiment

The reasons for differences in size and shape of head between the three transplanting depths in the field experiment was thought to be caused by the mechanical pressure of the soil on the plants transplanted deep. This

pressure caused the plants to grow more upright and restricted their lateral growth.

The mechanical pressure of the soil may have influenced the deep treated plants in the field experiment to mature slightly earlier than the other two treatments. Some other leafy crops may be induced to head by tying the leaves together to start heading.

Some of the responses observed were not anticipated and are difficult to explain. From the observations made it is impossible to determine if there was a definite difference in the length of the core among treatments for the whole plant. The observed differences in core length between transplanting depths may have been influenced by the harvesting techniques used. All the plants were cut at the soil level so that the stem was cut shorter on the deep transplanted plants than on the shallow or medium.

The increased curling of the leaves of the deep transplanted plants cannot be explained without further investigation into the morphological growth of plants subjected to deep transplanting.

There is no explanation for there being no significant difference in height of head between treatments. It appears that the deep transplanted plants should have produced heads that were taller than the other treatments because of the mechanical pressure of the soil. The compactness of the head apparently offset the growth in height on the deep transplanted plants. The shallow and medium transplanted plants produced heads of the same height as the deep, except they were not as compact and were broad across the top. The deep treated heads were definitely pointed at the top, as shown in figure 1.

VIII

SUMMARY

Three separate experiments were conducted to determine the influence of depth of transplanting on the size and shape of head of crisp-head lettuce. A hotbed experiment was conducted in the winter of 1950-1951. A greenhouse experiment was conducted in the spring and early summer of 1951. A final experiment, which was a modification of the other two, was conducted in the field in the early summer of 1951. The variety of lettuce used was Imperial 44 for all three experiments.

The lettuce was seeded in a seed flat and transplanted to Bird-10 Vita-Bands 1 1/2 inches by 1 1/2 inches in size. The plants were then transplanted into the growing areas at shallow, medium, and deep transplanting depths.

The hotbed and greenhouse experiments were inconclusive in their results but were of value in giving practice and growth information which made the field experiment more satisfactory in results.

The results of the field experiment showed that deep transplanted lettuce produced heads more conical, more compact, and more curly leaved than lettuce transplanted medium or shallow. The core length of deep transplanted lettuce was shorter than the core of shallow or medium transplanted. The heads from all three transplanting depths were the same in height but were significantly different in width. Heads from the deep transplanted plants had the narrowest width and were definitely more conical than the shallow or medium transplanted. The heads from the three transplanting depths weighed the same, which indicated the deep transplanted heads were smaller because they were more firm.

The shape of head was influenced by the added mechanical pressure of the soil around the plants. The compactness of head and conical shape of the deep transplanted plants appeared to be the result of soil pressure around the plant. Very compact heads, as observed on the deep treated plants, are undesirable where the lettuce is to be used as a garnish or in a sandwich because it is difficult to remove a leaf intact from such a head.

The results of this experiment indicates that deep transplanting of crisp-head lettuce should be avoided, and that the more shallow the plants are transplanted the more desirable the size and shape of the heads will be.

IX

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XI

BIOGRAPHICAL SKETCH

Mason Edwin Marvel was born in Brewton, Alabama, on December 11, 1921. He attended the public schools in Brewton for eight years, after which he attended Holtville High School in Deatsville, Alabama. After finishing high school in 1939, he went to New York City where he worked a year. He then returned to his home and worked as an automobile mechanic in Montgomery, Alabama, until he entered the United States Air Force in June of 1942. He served in the Pacific Theater of Operations and was Honorably Discharged in October of 1945. He was married in September of 1945 and has two boys, two and four years old. He entered the University of Massachusetts in September of 1946 and received his Bachelor's Degree in Olericulture in June of 1950. He entered Virginia Polytechnic Institute in September of 1950 and is doing his work for a Master's Degree.

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APPENDIX

Hotbed Data

Replicate 1.—Data taken from each head of lettuce in each transplanting depth, with totals and means for eight observations. Weights in ounces and measurements of core length, height, and width in inches.

Shallow Transplanting										
Plant Number	1	2	3	4	5	6	7	8	Total	Mean
Weight			12	17	16	22	15	17	99	16.87
Height			4.75	5.4	4.6	5.4	5.0	4.75	29.9	4.98
Width			3.5	4.0	4.0	5.2	4.5	4.5	25.7	4.28
Core Length			1.25	1.5	1.0	1.75	1.5	1.5	8.5	1.42
Medium Transplanting										
Plant Number	1	2	3	4	5	6	7	8	Total	Mean
Weight	8	16	13	17	15		18	17	104	14.86
Height	4.5	4.75	4.8	4.4	4.75		5.0	4.6	32.8	4.68
Width	4.25	5.25	4.25	4.75	4.0		4.8	4.5	31.8	4.54
Core Length	1.1	2.5	1.6	2.3	2.5	1.25	2.25	2.0	15.00	1.88
Deep Transplanting										
Plant Number	1	2	3	4	5	6	7	8	Total	Mean
Weight	15	19	14	13	15	19	15		110	15.71
Height	4.8	5.25	4.5	4.2	4.8	4.75	5.0		33.30	4.76
Width	4.25	4.5	3.8	4.0	4.8	4.75	4.0		30.10	4.30
Core Length	1.2	2.0	1.6	1.6	1.5	2.1	1.6		11.60	1.66

XII

APPENDIX

Hotbed Data

Replicate 2.—Data taken from each head of lettuce in each transplanting depth, with totals and means for eight observations. Weights in ounces and measurements of core length, height, and width in inches.

Shallow Transplanting										
Plant Number	1	2	3	4	5	6	7	8	Total	Mean
Weight	13		13		12		14	14	66	13.2
Height	4.0		4.0		4.1		4.0	4.2	20.30	4.06
Width	3.75		4.0		4.25		4.0	3.75	19.75	3.95
Core Length	2.0	1.3	2.75	2.25	2.25	3.0	3.5	3.25	20.30	2.54
Medium Transplanting										
Plant Number	1	2	3	4	5	6	7	8	Total	Mean
Weight	11	11	13	14	14	16	10	17	106	13.25
Height	3.0	4.2	3.25	4.0	3.75	4.5	3.75	4.25	30.70	3.84
Width	2.7	4.2	4.0	4.8	5.0	4.75	3.25	4.25	32.95	4.12
Core Length	0.7	1.5	2.0	1.6	2.0	3.25	2.0	3.2	16.25	2.03
Deep Transplanting										
Plant Number	1	2	3	4	5	6	7	8	Total	Mean
Weight	15	10			10				35	11.67
Height	4.8	4.25			3.9				12.95	4.32
Width	4.25	3.75			3.75				11.75	3.92
Core Length	2.0	1.8	3.25	2.4	2.6		3.4	3.2	18.65	2.66

XII

APPENDIX

Hotbed Data

Replicate 3.—Data taken from each head of lettuce in each transplanting depth, with totals and means for eight observations. Weights in ounces and measurements of core length, height, and width in inches.

Shallow Transplanting										
Plant Number	1	2	3	4	5	6	7	8	Total	Mean
Weight		8	16	15	13	18	21	18	109	15.57
Height		3.5	3.75	4.75	4.6	3.25	5.25	5.25	30.35	4.34
Width		3.75	4.25	4.5	4.5	2.5	4.5	4.5	28.50	4.07
Core Length		1.5	1.5	1.0	1.0	1.25	1.5	1.5	9.25	1.32
Medium Transplanting										
Plant Number	1	2	3	4	5	6	7	8	Total	Mean
Weight	11	16	16	15	12	17	15	15	117	14.62
Height	4.25	4.2	4.0	5.0	4.5	5.0	5.0	4.5	36.45	4.56
Width	4.25	5.0	4.75	4.5	3.6	4.25	3.5	3.5	33.55	4.19
Core Length	2.25	2.25	1.25	0.8	0.6	1.2	0.8	1.0	10.15	1.26
Deep Transplanting										
Plant Number	1	2	3	4	5	6	7	8	Total	Mean
Weight		22	16	18			12	8	76	15.2
Height		5.4	4.8	5.25			4.75	3.25	23.45	4.69
Width		5.0	4.0	3.75			2.5	1.75	17	3.40
Core Length		3.5	2.0	1.2			1.25	0.75	8.7	1.74

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APPENDIX

Field Plot Data

Replicate 1.—Data taken from each head of lettuce in each transplanting depth, with totals and means for ten observations. Weights in ounces and measurements of core length, height, and width in inches.

Shallow Transplanting												
Plant Number	1	2	3	4	5	6	7	8	9	10	Total	Mean
Weight	24	18	22	24	18	22	12	23	21	25	209	20.90
Height	5.7	5.2	5.5	5.8	4.8	6.0	5.2	5.1	5.2	5.8	54.3	5.430
Width	5.8	4.75	5.3	4.9	5.2	4.9	4.6	5.0	5.25	6.0	51.7	5.170
Core Length	1.6	1.0	1.6	2.2	1.5	1.75	1.1	1.5	2.0	2.0	16.25	1.625
Medium Transplanting												
Plant Number	1	2	3	4	5	6	7	8	9	10	Total	Mean
Weight	19	16	19	22	17	17	25	24	24	23	206	20.60
Height	5.6	5.75	5.3	6.5	5.4	5.5	5.3	6.1	5.6	5.5	56.55	5.655
Width	4.1	5.2	5.3	5.4	4.5	5.0	4.1	4.5	4.2	4.75	47.05	4.705
Core Length	1.4	1.6	1.25	1.5	1.0	1.7	1.7	1.8	1.6	1.75	15.30	1.530
Deep Transplanting												
Plant Number	1	2	3	4	5	6	7	8	9	10	Total	Mean
Weight	11	21	22	19	14	20	13	19	19	12	170	17.00
Height	4.5	5.1	6.0	5.5	4.5	5.75	4.75	5.2	4.25	4.6	50.15	5.015
Width	2.75	4.15	3.6	4.25	3.5	4.0	3.25	4.6	3.3	3.0	36.40	3.640
Core Length	0.8	1.25	1.5	1.2	1.5	1.2	1.0	1.6	0.7	0.75	11.50	1.150

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APPENDIX

Field Plot Data

Replicate 2.—Data taken from each head of lettuce in each transplanting depth, with totals and means for ten observations. Weights in ounces and measurements of core length, height, and width in inches.

Shallow Transplanting												
Plant Number	1	2	3	4	5	6	7	8	9	10	Total	Mean
Weight	22	18	23	18	20	20	16	18	13	22	190	19.00
Height	5.6	5.3	5.4	4.8	5.3	5.2	4.8	5.0	4.7	6.0	52.10	5.210
Width	5.0	4.0	5.5	4.4	4.5	4.6	3.75	4.75	4.5	5.5	46.50	4.650
Core Length	1.6	1.2	1.5	1.25	1.2	1.25	1.25	1.7	1.5	1.75	14.20	1.420
Medium Transplanting												
Plant Number	1	2	3	4	5	6	7	8	9	10	Total	Mean
Weight	24	18	22	23	17	23	17	22	22	20	208	20.80
Height	5.4	5.75	5.25	5.5	5.7	6.5	4.75	5.4	6.25	5.2	55.70	5.570
Width	5.1	4.2	4.0	5.3	4.8	4.9	4.1	4.3	4.75	4.4	45.85	4.585
Core Length	1.4	1.1	1.5	1.6	1.5	1.65	1.6	1.25	1.25	1.5	14.35	1.435
Deep Transplanting												
Plant Number	1	2	3	4	5	6	7	8	9	10	Total	Mean
Weight	17	22	21	19	22	20	19	22	20	20	202	20.20
Height	5.5	6.25	5.6	5.5	4.5	5.6	5.0	5.75	6.7	6.1	56.50	5.650
Width	3.8	5.0	3.8	3.4	2.5	4.75	3.5	4.0	3.7	5.0	39.45	3.945
Core Length	1.7	1.5	1.1	1.1	1.75	1.5	1.0	1.5	1.4	1.4	13.95	1.395

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APPENDIX

Field Plot Data

Replicate 3.--Data taken from each head of lettuce in each transplanting depth, with totals and means for ten observations. Weights in ounces and measurements of core length, height, and width in inches.

Shallow Transplanting												
Plant Number	1	2	3	4	5	6	7	8	9	10	Total	Mean
Weight	25	23	22	25	22	23	22	22	22	21	227	22.70
Height	5.0	5.5	5.75	6.0	4.9	5.5	5.25	5.25	4.25	4.8	52.20	5.220
Width	5.0	5.4	5.25	6.0	3.8	5.25	5.0	4.5	3.7	4.5	48.40	4.840
Core Length	1.4	1.4	2.75	2.25	1.5	2.0	1.25	2.25	1.6	1.2	17.60	1.760
Medium Transplanting												
Plant Number	1	2	3	4	5	6	7	8	9	10	Total	Mean
Weight	20	22	20	19	21	18	20	22	24	23	209	20.90
Height	5.5	5.5	6.0	5.3	5.75	5.3	5.75	4.6	5.25	5.4	54.35	5.435
Width	4.75	4.4	5.0	4.4	4.0	4.75	5.25	4.25	4.5	4.2	45.50	4.550
Core Length	1.6	1.5	1.65	1.2	1.4	1.5	1.75	1.5	1.75	1.4	15.25	1.525
Deep Transplanting												
Plant Number	1	2	3	4	5	6	7	8	9	10	Total	Mean
Weight	23	20	21	16	20	20	19	20	19	21	199	19.90
Height	5.75	5.6	5.2	4.5	5.1	6.0	6.1	4.9	5.15	5.3	53.60	5.360
Width	4.3	3.6	3.5	3.4	2.75	3.4	3.6	3.1	3.25	3.6	34.50	3.450
Core Length	1.3	1.1	1.2	0.75	1.0	1.5	1.25	1.0	1.25	1.25	11.60	1.160

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APPENDIX

Field Plot Data

Replicate 4.—Data taken from each head of lettuce in each transplanting depth, with totals and means for ten observations. Weights in ounces and measurements of core length, height, and width in inches.

Shallow Transplanting												
Plant Number	1	2	3	4	5	6	7	8	9	10	Total	Mean
Weight	19	21	17	20	20	22	16	21	23	18	197	19.70
Height	5.5	5.5	5.0	5.0	5.6	5.0	5.5	5.5	4.8	4.5	51.90	5.190
Width	5.4	4.75	4.5	5.0	4.8	4.25	5.25	5.4	5.0	4.5	48.85	4.885
Core Length	1.5	1.2	1.8	1.3	1.4	1.25	1.6	1.9	1.4	1.5	14.85	1.485
Medium Transplanting												
Plant Number	1	2	3	4	5	6	7	8	9	10	Total	Mean
Weight	22	23	14	22	20	22	21	18	23	21	206	20.60
Height	5.6	5.75	4.3	6.1	5.1	5.5	5.5	4.6	5.4	5.3	53.05	5.305
Width	5.7	4.5	4.0	5.9	4.0	5.0	4.2	5.4	4.5	4.4	47.60	4.760
Core Length	1.6	1.25	1.0	1.75	1.5	1.4	1.3	1.0	1.5	1.6	13.90	1.390
Deep Transplanting												
Plant Number	1	2	3	4	5	6	7	8	9	10	Total	Mean
Weight	15	14	21	20	18	24	20	18	20	17	187	18.70
Height	5.4	5.0	5.8	5.5	5.1	5.4	5.0	4.75	5.3	5.5	52.75	5.275
Width	3.5	3.1	3.5	3.8	3.75	3.75	4.5	3.4	4.5	3.5	37.30	3.730
Core Length	1.0	1.5	1.25	1.2	1.1	1.25	1.5	1.0	1.25	1.0	12.05	1.205