A SPACING AND FERTILISER TRIAL WITH CABBAGE

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1. A spacing and fertilizer trial comparing two varieties of cabbage, Charleston Wakefield and Succession, was conducted in Trinidad in the year 1958-1959. Four spacings (12" x 12", 15" x 15", 18" x 18" and 24" x 24") and two levels of each of sulphate of ammonia and triple superphosphate were used. Sulphate of ammonia was applied at the rate of 0 and 4 cwts per acre and triple superphosphate at 0 and 2 cwts.

The experiment was extremely successful.

2. Higher yields per unit area were obtained from the closer spacings of Cabbage. Marketable yields of the closer spacings (12" x 12", 15" x 15" and 18" x 18") were significantly higher than that of the widest one (24" x 24"). No significant result was found between the three closer spacings.

3. Significant response to nitrogen was found in the marketable yields per unit area but there was no response to phosphorus. The interaction between nitrogen and closer spacings was highly significant.

4. Yields per plant decreased with plant density and the largest cabbage heads were produced in the widest spacing.

5. Besides yields, spacing also effected percentage of marketable heads, and the time to maturity. A hundred percent of cabbage plants at the wider spacings (18" x 18" and 24" x 24") reached maturity. A small percentage of plants in the closer spacings failed to form heads at all. Early maturity occurred in the wider spacings and in the close spacings maturity was delayed.
6. No obvious difference was found in the percentage of waste (outer leaves) between all treatments of variety Succession, but in the variety Charleston Wakefield the closest spacing gave the highest percentage of such waste. Also, the application of N and P produced more outer leaves than that of the other fertiliser treatments.

7. In comparing the two varieties, no statistical differences were found in marketable yields per both unit area and plant. However, Charleston Wakefield was found more superior to Succession in early maturity, tolerance to closer spacings, higher percentage of marketable heads, less percentage of waste and produced more compact and solid heads.
I. INTRODUCTION.

Cabbage (Brassica oleracea, var. capitata L.) is the most common vegetable among the cole crops, and it is recognised to be one of the most important vegetables in the garden. In the Temperate regions, cabbage supplies green food in constant succession throughout the year and is popular with all classes of the community. Its value as a vegetable lies in the fact that its green leaves are a good source of vitamin B1 and C, and also contain various kinds of minerals including calcium, magnesium, phosphorus and iron.

It belongs to the family Cruciferae and is probably a native of Western Europe and the North shore of the Mediterranean. About 4,000 years ago, people were eating the leafy wild cabbage. The cultivated cabbage however was not described until A.D. 900-1,000. Through hybridization and selection since that time, there are now many types of cultivated cabbages differing in size, shape, and colour of the leaves and in size, shape colour and texture of the heads.

In general, cabbage can be grown in most parts of the world within a wide range of climate and soils. Best results are obtained in a relatively cool moist climate and on fertile sandy loam soils.

Economically it is important to many growing countries. In the U.S.A. the annual value of this crop is more than 41 million dollars (20). In Hong Kong, where the total cultivated area is only 35,000 acres, the total annual production of cabbage is up to 16,770 tons valued at $589,083 U.S. (32). During the main growing season (September to March), besides satisfying the local demands of 3 million people, some of the crop is exported to Malaya, Singapore and North Borneo. In Great Britain, cabbage is grown commercially for human consumption on a very large scale and it ranks as one of
the most important vegetables (1).

In Trinidad, this vegetable is grown in market gardens in large quantity during the cooler months of the year (January - April). Good heads are only obtained if it is properly cultivated coupled with adequate control of pests and diseases.

In the past, people in the tropics have tended to ignore the necessity of green vegetables in their diets. Because of this and other reasons, little work has been done to select varieties under tropical conditions or improve the standards of cultivation. With the current realization of the greater need for the production of green vegetables and food crops under local tropical conditions, it is hoped that investigations will in the future be carried out on these crops. As part of an improvement programme in Trinidad, the writer carried out a spacing and fertiliser trial on two varieties of cabbage and this is described.

The most important vegetables (1).

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(a) Early varieties;

(b) Intermediate or Mid-season varieties;

(c) Late varieties;

This classification is practically adopted by many workers and in Florida, Michigan and three other workers (4) give the approximate number of days required by these three main groups from transplanting to maturing. Under Florida conditions, early varieties usually produce heads within 60-65 days from transplanting, mid-season varieties within 72 to 90 days and late varieties within 95 - 130 days.

In Florida also where local cabbage can be grown throughout the year, the largest and heaviest heads are only produced during the cool season and most standard varieties produce crops satisfactory by September.
II. REVIEW OF LITERATURE & LOCAL CULTIVATION METHODS.

In general, there is very little research work being done in the tropics on the cabbage crop and practically no published information is available. Under such circumstances, most of the reviews were therefore obtained from literature published in temperate countries. Though climatic and soil conditions are vastly different between the two areas, it is valuable to record this information not only for future reference, but also for possible application locally.

1. Variety.

Whilst the main object of the experiment was not to test various cabbage varieties, it is appropriate to discuss briefly what varieties are most commonly grown in the Caribbean area.

There are a considerable number of varieties of cabbage listed by seedsmen and Shoemaker (2) classifies them into three main groups:

(a) Early varieties;
(b) Intermediate or Midseason varieties;
(c) Late varieties.

This classification is practically adopted by many workers and in Florida, McCubbin and three other workers (4) give the approximate number of days required by these three main groups from transplanting to maturing. Under Florida conditions, early varieties usually produce heads within 60-85 days from transplanting, midseason varieties within 75 to 95 days and late varieties within 95 - 120 days.

In Puerto Rico where head cabbage can be grown throughout the year, the largest and heaviest heads are only produced during the cool season and most standard varieties produce crops satisfactorily during...
this period. However, in variety trials carried out there, Golden Acre, Succession (All Season) and Copenhagen Market produced the largest percentage of good heads (3).

In Jamaica (31), Early Jersey Wakefield and Charleston Wakefield are the most popular quick-growing varieties. All Head Early has been shown to be a slower growing variety. Drum Head, Flat Dutch and Copenhagen Market are later varieties producing large heads.

At the Imperial College of Tropical Agriculture, Trinidad, Campbell (29) compared eleven varieties from G.E. Govier & Co. Ltd., Quebec, Canada with eleven varieties from W. Atlee Burpee, Philadelphia, U.S.A. in 1954–55. Results showed that Henderson Succession from Govier was outstanding by giving 2.8 lbs of marketable weight per head. This was followed by All Head Early, All Season and Premium Late Flat Dutch.

Seed sales at the Marketing Board and other firms in Trinidad show that the varieties Charleston Wakefield, All Seasons, Marion Market and Copenhagen Market are the most in demand.

2. Spacing.

Similar results with the spacing of cabbage have been shown by most experimental workers under temperate conditions.

In the United Kingdom, Hoare (1) has however pointed out that in determining the planting distance for cabbage, such factors as the variety of cabbage used, the type of land and the manuring given must be taken into account. For the smaller earlier types, he recommends a spacing between rows of 24" - 30" and between plants 12" - 15". In general, he states that total yields are increased with close planting, but the individual size of the head tends to be smaller.
In California, U.S.A., the American authors, Knott and Minges (5) have shown similar results to Hoare. They state the close spacing between rows and in the rows should be used for the small varieties while the large-headed types should be given relatively wide spacings. They also proved that the size of head can be influenced by the spacing provided. Several distances are therefore proposed by them according to the size of varieties.

- Small varieties 12" - 15" both ways;
- Medium 15" - 18" both ways;
- Large (ordinary heads) 18" - 24" both ways;
- (very large heads) 36" between row and plant.

In his book 'Vegetable Crops', Thompson (6) has a clear explanation on the spacing of cabbage which is in complete agreement with the above three authors. He also states that spacing of the plants depends largely on the variety. His recommendation is as follows:

- Small varieties 24" - 36" apart between row and 12" - 15" in row;
- Large varieties 28" - 36" apart between row and 18" in row.

In his book Shoemaker (2) working in the U.S.A. states that:

'In general, the relatively wide spacing contributes towards earliness and larger, heavier heads. Yield per acre and no. of heads harvested usually are increased by close spacing and where the demand is for medium sized heads, the spacing should be a little closer than where large heads are desired. Close planting tends to cause the outer leaves to be shorter and more incurved or spoon shaped, giving a more rosette-like appearance than is typical for the variety. Small growing varieties may be set 12" - 15" apart in rows 2 - 3 ft.apart, and large
kinds are set 18" apart in rows 28" - 36" apart.

A considerable amount of waste often occurs in the cabbage and the percentage of such waste might be correlated with spacings. In his experiments extending over 2 years with the cabbage variety 'Balinkai', Somos (7) found out that the highest yield combined with the lowest production cost was obtained when the plants were spaced at 40 x 50 cm (15.6" x 19.5"). The proportion of edible parts at this spacing amounted to 31.5% of the total yield and he concluded that the closer planting resulted in a higher percentage of waste.

The most recent information obtained among all available references concerning spacing of cabbage is contained in Vittum and Peck's report (8) on 'Response of Cabbage to Irrigation, Fertility level and Spacing'. This experiment was carried at the Cornell University, U.S.A. during the four-year period 1952-55, and in conclusion, they found the following interesting results:

a. 'Close spacing of plants in the row reduced the percentage of burst heads and greatly reduced the average weight per head, but because of the much larger number of heads per acre, it very significantly increased the marketable yield and also the gross yield of cabbage.'

b. 'The response of cabbage to close spacing was influenced by the fertility level and irrigation. The response to close spacing was larger at the high fertility level than at the normal fertility level. Likewise, the response to close spacing under irrigation was greater than without irrigation. In other words, maximum yields were obtained from close-spaced cabbage in heavily fertilised soil irrigated as needed so that the large plant population was continuously supplied with an abundance of plant nutrients and water.'
Recommendations of spacings from other places, many not actually based on experimental work, are listed below:

<table>
<thead>
<tr>
<th>Author</th>
<th>Varieties</th>
<th>Inter-row distance</th>
<th>Inter-plant distance</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moss &amp; Wright (9)</td>
<td>large</td>
<td>24&quot;</td>
<td>18&quot;</td>
<td>Russia</td>
</tr>
<tr>
<td>Smith (10)</td>
<td>av. head size</td>
<td>18&quot;</td>
<td>18&quot;</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Puerto Rico Ag. Expt. Station, (3)</td>
<td>small large</td>
<td>12&quot; 18&quot;</td>
<td>12&quot; 18&quot;</td>
<td>Puerto Rico</td>
</tr>
<tr>
<td>Puerto Rico Ag. Expt. Station (11)</td>
<td>-</td>
<td>24&quot; -40&quot;</td>
<td>10&quot; -20&quot;</td>
<td>Florida, U.S.A.</td>
</tr>
<tr>
<td>Dept. of Agri. Trin. &amp; Tobago (12)</td>
<td>-</td>
<td>24&quot;</td>
<td>24&quot;</td>
<td>Trinidad</td>
</tr>
<tr>
<td>Gollan (13)</td>
<td>-</td>
<td>18&quot;</td>
<td>18&quot;</td>
<td>India</td>
</tr>
<tr>
<td>Cunliffe (14)</td>
<td>-</td>
<td>30&quot; -42&quot;</td>
<td>18&quot; -22&quot;</td>
<td>Trinidad</td>
</tr>
<tr>
<td>Chisholm (15)</td>
<td>late</td>
<td>18&quot;</td>
<td>15&quot;</td>
<td>Scotland</td>
</tr>
<tr>
<td>Rolf (16)</td>
<td>early large</td>
<td>15&quot; 36&quot;</td>
<td>12&quot; 24&quot; -36&quot;</td>
<td>Southern U.S.A.</td>
</tr>
<tr>
<td>Jamaica Agri. Society (31)</td>
<td>small large</td>
<td>18&quot; 24&quot;</td>
<td>18&quot; 24&quot;</td>
<td>Jamaica</td>
</tr>
</tbody>
</table>

3. Fertiliser.

It has been shown by most workers in various parts of the world that cabbage is a gross feeder and draws heavily on the mineral supplies of the soil. Of the three principal elements, N.P.K., Nitrogen is recognised as the primary nutrient needed by the crop. In California, where soils have developed under low rainfall conditions and have little organic matter in them, Lingle (17) emphasizes the importance of the use of nitrogenous fertiliser in growing cabbage. An amount of 100 to 120 lbs of Nitrogen per acre is recommended by him. Experiments also showed that cabbage responds to the application of some phosphorus in the cool season.
even though the soil is considered well supplied with this nutrient. He recommends the use of 60 lbs of P₂O₅ per acre in addition to the Nitrogen application. Knott & Minges (5), also in California, support the statement of Lingle. They have shown that on many soils, particularly during the Winter period, cabbage will respond to an application of 50 to 100 lbs of Nitrogen per acre but that response to Phosphorus is more marked during the winter season than at other seasons.

Whilst large, well-developed leaves are important to form a good head of cabbage, thereby necessitating a steady supply of Nitrogen, Shoemaker (2) gives a warning that excessive Nitrogen feeding without suitable balance of other elements may result in spongy instead of crisp, firm heads. He states that manure plus superphosphate will give better results than manure alone.

As with many other crops, the response of cabbage to fertiliser on light soils is different from heavy soils. Thompson (6) indicates that when cabbage is grown on sandy loam soils without manure, a fertiliser supplying 75 to 100 lbs of each of the three important elements can be used to advantage, but on heavy soils, relatively more phosphoric acid seems desirable.

Confirming Thompson's observations, Knott (18) proposes the following mixtures for light and heavy soils.

(a) Early crop on light soils with little manure, the fertiliser required per acre should contain 100 to 125 lbs of each of the three principal nutrients, N, P₂O₅, K₂O.

(b) Early crop on heavier soils, apply more phosphoric acid. A ratio 1:2:1 at a rate that will furnish the crop with at least 75 lbs of Nitrogen.
In the United Kingdom, Nitrogen and Phosphate are, as in the U.S.A. recognised as essential to the crop. Hoare (1) recommends the following applications:

a. A treatment of 10 tons of farm yard manure per acre supplemented with a good dressing of a complete fertiliser, high in Phosphate, with an analysis such as 4-12-4 and 4-16-4.

b. On land receiving no manure for the crop, a complete fertiliser (5-10-5) at the rate of 600-1,000 lbs per acre supplemented by 6-10 cwts of hoof and horn meal.

c. Cabbage crops respond well to nitrogenous top dressings. Application to be given six weeks after planting with 150 to 200 lbs. of sulphate of ammonia per acre.

Smith (10) working in the United Kingdom, is also of the strong opinion that the liberal application of farm yard manure is essential to high yields of cabbage. He goes on to state that the presence of lime in the soil is important to healthy growth. For this reason, he recommends the use of basic slag rather than superphosphate. In Jamaica (31), it was found that cabbage feeds very heavily on lime. Even though the crop flourishes on a wide range of soils there, for maximum development, it prefers a deep fertile loam well supplied with lime.

Working in New York, Sayre and Vittum (19) compared, over a four year period (1946-49), the application of a complete fertiliser mixture, 5-10- -10 at four rates, 0 lbs., 600 lbs, 1,200 lbs., and 1,800 lbs. per acre. The variety used was Marion Market. Results showed that, over the four years, the 600 lbs per acre rate produced a significant increase of 2.5 tons per acre over no fertiliser. The 1,200 lbs of fertiliser per acre produced an additional 1.9 tons of cabbage per acre, which was a significant gain over the 600 lbs. rate
of application. Adding the third 600 lbs increment of this fertiliser produced only 1 ton per acre additional yield, which was not a significant gain. The experiment concluded that yields of cabbage were significantly increased by application of 5-10-10 fertiliser up to 1,200 lbs per acre but above that rate, the small additional increase was not significant.

This experiment was confirmed later by another field trial by Vittum and Peck (8) in the years 1952-55. This was also carried out at the New York State Agricultural Experimental Station but the variety used in this case was Wisconsin All-Season. The response to the extra fertiliser was again small. Thus, doubling the normal rate of complete fertiliser (The normal rate being 8-16-16 at 800 lbs per acre) produced only 0.6 ton of extra marketable yield per acre.

It is of interest to add two recommendations from the Caribbean. The Department of Agriculture, Trinidad and Tobago (12) suggests that a good amount of farmyard manure and a complete fertiliser should be incorporated into the soil before planting and this should be followed by a side dressing of sulphate of ammonia or liquid stable manure applied when the heads begin to form or if any signs of yellowing of the leaves are noticeable. No actual rates are given. In Puerto Rico (3) where climatic conditions are similar to those in Trinidad, completely the same suggestions are given by the Agricultural Experimental Station there.

4. Cultivation by Peasant Farmers in Trinidad.

To fully appreciate the local methods and problems of production, a general survey was made around the Aranguez area where the majority of cabbages in Trinidad are produced. Information was obtained by enquiries amongst the growers and from practical observations.
Cabbage is an important crop there during the dry season, January to June. It follows rice which is normally harvested in November.

a. Variety and Seed: Charleston Wakefield, Jersey Wakefield, Copenhagen Market, Early Flat Dutch, All Head Early and Succession (All Season) are the common varieties grown and Charleston Wakefield seems the most popular. Seeds are normally imported from the U.S.A. through the Marketing Control Board in Port of Spain and the price at the time of enquiry was 84£ per oz.

b. Seed Bed: The size of seed bed is commonly 3 ft wide x 20 ft long x 1 ft high on which 1 oz of seed is sown. Before sowing, the bed is well prepared and pen manure applied at the rate of 25 - 30 lbs per bed. Insecticides, usually 'dieldrex' or 'agroicide' are sprayed on to control mole crickets. The seed is then broadcast after which a cover of rice straw or dried grass is put on top of the bed to conserve soil moisture and to prevent the eating of seeds by birds. This cover is removed after seed germination. Hand watering by can is done twice a day in dry weather after sowing. Sulphate of ammonia is the only artificial fertiliser, which is used for top dressing the young seedlings. About 3 - 4 ozs are diluted into water and applied to each bed about two weeks after sowing. One more dose may be given seven days later if required. It is clear that many growers give another top dressing of sifted farm yard manure over the bed and they believe that this is quite helpful in protecting the exposed delicate roots. Spraying of insecticides for the control of insects is essential particularly Bud worm (Hollulu phidilealis Wlk.) Commonly lead arsenate at the concentration of 4 ozs to 2 gals of water is used. This may be mixed up with one table spoonful of 'Fosfemo' (Parathion) and another tablespoonful of 'Aldrex' or 'Dieldrex'. The seedlings are ready for transplanting in about thirty
days. Some midseason varieties may not be transplanted until six weeks in the nursery.

c. Field work: After the rice harvest, the field is cutlassed, the rice straw burnt, and drained. It is divided into beds 18-20 ft wide with a drain about 1 ft deep and 1½ ft wide in between. The land is then normally rotary hoed generally by a contractor using a Ferguson or David Brown tractor at a cost of $20 - $30 per cut (i.e. one operation). Ordinarily 1 - 2 cuts are sufficient but some land needs 3 cuts depending on the consistency of the soil. Some growers prefer ploughing and harrowing.

Holes are dug about 6" deep and 4" wide spacing at 16"-18" both ways. A handful of farm yard manure is applied to each hole and before transplanting, the soil is moderately moistened. Seedlings are set out in the field in the afternoon after 2.30 p.m. Irrigation is conveniently done by watering the plants from the drain. This is kept filled up all the time by water leading in from an upper dam.

Fertilisers are applied in the following ways:

1st application - 8 days after transplanting with sulphate of ammonia @ ½-3 oz. per plant;

2nd application - 15 days later, same dose;

3rd application - another 15 days later, same amount of sulphate of ammonia or 'Holland salt' (a complete artificial fertiliser containing 12% N, 10% P₂O₅, and 18% K₂O) at the rate of ½ to 1 oz. per plant.

Hand weeding is necessary once or twice before heading is complete. Spraying is carried out weekly with the same mixture of
insecticides as used in the nursery. The early varieties mature in about 50 - 60 days after transplanting while the mid-season ones are not available for harvesting until 60-70 days. With all varieties, the harvesting period lasts for 3-4 weeks and a number of harvests are taken. The work is carried out in the late afternoon and cabbages are taken to the market in Port of Spain or San Juan early next morning.

d. Yield and Economical Return: Early varieties such as Charleston Wakefield yield from \( \frac{1}{2} \) - 2 lbs per head and the mid-season varieties may reach up to 3 lbs. Market price varies from season to season but the range is from 6¢ to 25¢ per lb.

Cost of production of one acre of cabbage (about 20,000 heads) is roughly estimated at $500 - $700 and the minimum return is about $1,200 - $1,500.

e. Pests and Diseases: The worst insect pests are the Cabbage White Butterfly (Ascia monuste L.), the bud or heart worm (Hellula phidialis Wilk.), and Mole Crickets (Scapteriscus vicinus Scudden). Aphid, leaf miner and flea beetles sometimes cause damage. Cultivators are fully aware that no cabbage heads could be produced if they did not control the larvae of the bud worm and white butterflies.

Among the diseases, Downy Mildew (Peronospora parasitica Pers. ex Fr.) is a common fungus disease attacking nursery seedlings particularly under hot damp conditions. Rhizoctonia (Fiscalicularia filamentososa R.) and Yellows (Fusarium oxysporum f. conglutinans Wr.) appear on some occasions in the field. No preventive or control measures against these fungus diseases are taken by the peasant farmers at all.
5. **Summary of Review.**

**Variety:** There appears to have been no adequate trials to determine the most suitable variety for Trinidad conditions. It seems necessary that more varieties should be introduced making careful observations. To study these varieties, the important characteristics which determine their adaptability must be considered. Such characteristics should include heat resistance, yielding ability, time of maturity, resistant to disease and bolting and the production of small to medium sized solid heads.

**Spacing:** The following points are recommended by all authors and workers:

a. The spacing of cabbage is determined by varieties, climatic conditions, fertility of the land and the market demand.

b. Close spacing definitely increases the yield per acre because of the larger population of plants but the individual size of head tends to be smaller.

c. Wide spacing produces large heads of cabbage but less yield per unit area.

d. As big sized-heads are not favoured by local Trinidad house wives, peasant farmers prefer close spacing about 18" x 18".

**Fertiliser:** Nitrogen is recognised by all experimental workers as well as local cultivators as the most important nutrient for the cabbage crop. Furthermore it is agreed that a basic amount should be applied at planting and this should be followed by a top dressing before heading. Next to Nitrogen, Phosphate is also recommended by most
workers particularly on heavier soils and under the cool weather conditions. Excessive application of fertiliser to the crop does not appear to give a significant increase in yields. It is important that the optimum requirement for a particular area should be found out.

1. To compare the yield and seed size of the varieties 'Carlea', 'Carleafield', and 'Eastfield'.

2. To study the effects of four different spacings on the yield per plant and yield per unit area of the two varieties.

3. To evaluate the response of the crop to various levels of Nitrogen/Phosphate, and to note the effect of their interaction with that of the spacings.
III OBJECTS OF THE EXPERIMENT.

The aims of the experiment were the following:

1. To compare the yield and head size of the varieties 'Charleston Wakefield' and 'Succession'.

2. To study the effects of four different spacings on the yield per plant and yield per unit area of the two varieties.

3. To evaluate the response of the crop to various levels and of Nitrogen/Phosphate, and to note the effect of their interaction with that of the spacings.
IV. MATERIALS AND METHODS

1. Variety.

Charleston Wakefield is probably the most popular variety among the early types in Trinidad and Succession has been shown to be a high yielding variety of the mid-season type. It was for these reasons that they were selected.

Charleston Wakefield is a popular old variety producing small plants with pointed heads of high quality, a short stem medium green in colour. It bolts slowly and when mature is surrounded by only a few outer leaves.

Succession is a hardy variety able to withstand hot, dry weather. It is a large vigorous, medium green and spreading type of cabbage with flat, solid and compact heads.

Seed was obtained from the Asgrow Seed Co., in the U.S.A., through Thompson & Co. Ltd., Edward Street, Port of Spain in Trinidad.

2. Spacing.

Judging by results from other places and the fact that the traditional spacing of cabbage in Trinidad is from 16" - 18" apart either ways, it was considered that a range from 12" - 24" square should be investigated. The following four spacings were therefore included in the experiment.
3. Plot size and number of plants per plot.

The size of each individual plot was 20 ft x 12 ft. All the plants in the outer rows were treated as discards. The total number of plants according to the spacing is shown in the following table:

<table>
<thead>
<tr>
<th>Spacing</th>
<th>No. of expt. plants</th>
<th>No. of discarded plants</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot; x 12&quot;</td>
<td>180</td>
<td>60</td>
<td>240</td>
</tr>
<tr>
<td>15&quot; x 15&quot;</td>
<td>98</td>
<td>46</td>
<td>144</td>
</tr>
<tr>
<td>18&quot; x 18&quot;</td>
<td>66</td>
<td>38</td>
<td>104</td>
</tr>
<tr>
<td>24&quot; x 24&quot;</td>
<td>32</td>
<td>28</td>
<td>60</td>
</tr>
</tbody>
</table>

4. Fertiliser.

As nitrogen is the chief nutrient required by cabbage, two levels of nitrogen treatments were included, 6 cwt and 4 cwt. of sulphate of ammonia (20.6%N) per acre.

Phosphate was also recognised essential for the cabbage crop and again two levels of phosphate treatments were included, 0 cwt.
and 2 cwts of triple superphosphate (48% P$_2$O$_5$) per acre.

Potash was applied uniformly to all plots at the rate of 1 cwt. of muriate of potash (60% K$_2$O) per acre.

All P and K and half of the sulphate of ammonia were applied as basic fertilisers one week before transplanting. The other half of the nitrogenous fertiliser was given about one month after transplanting just before the heads were forming.

5. Experimental Design.

A 4 x 2$^3$ factorial confounded design with one replication was employed in this experiment. Replicate III of the 2$^5$ confounded design given by Cochran & Cox (21) was modified.

In the design, there were 4 blocks with eight treatments in each block. Absence of 'a' and 'b' in the original design was denoted here by S1 (i.e. 12" x 12" spacing).

'a' in the design represented S2 (i.e. 15" x 15" spacing)

'b' in the design represented S3 (i.e. 18" x 18" spacing)

'ab' in the design represented S4 (i.e. 24" x 24" spacing)

'c' represented two varieties VI (Charleston Wakefield) and V2 (Succession); absence of 'c' meant VI and presence of 'c' meant V2.

'd' represented two levels of Nitrogens, nil and 4 cwts. of sulphate of ammonia per acre; presence of 'd' meant Nitrogen applied.

'e' represented two levels of Phosphate, nil and 2 cwts of triple superphosphate per acre; presence of 'e' indicated P applied.
All treatments of plots were allocated in the blocks by the use of a table of random numbers contained in Cochran & Cox's 'Experimental Design' and the four blocks were also arranged in two cambered beds at random. Details of the design and field layout are contained in Appendix 2a and 2b.

Sedimentation

The soil type of the experimental site, together with another large area of the New College Farm, is classified by Chemeley (22) as River Delta sandy loam. It is developed in the Northern Range alluvium and has a high content of fine sand and silt. The top soil is uniform dark yellowish brown loam to fine sandy loam. Exceptionally poor drainage tends to be water logged in the wet season. The soil is fairly acid and low in fertility.

Climate

The climate in Trinidad is described by Belcher (23) as typical of the insular tropics with a fairly heavy and well-distributed rainfall for some nine months in the year and a drier season for the remaining three months.

According to the climatic data recorded by the Imperial College of Tropical Agriculture, the mean values for 31 years (1928-49) are as follows:

1. Mean annual maximum air temperature 31°7
V. EXPERIMENTAL SITE.

1. Location.

The experiment was conducted on two adjacent cambered beds no. 22 and 23 in the Market Garden section of the New College Farm which lies about three miles west of the College along the Churchill Roosevelt Highway. Each of these beds was about 275 ft long and 25 ft wide running from East to West.

2. Soil condition.

The soil type of the experimental site, together with another large area of the New College Farm, is classified by Chenery (22) as River Estate sandy loam. It is developed on the Northern Range alluvium and has a high content of fine sand and silt. The top soil is uniform dark yellowish brown loam to fine sandy loam. Drainage is poor and it tends to be water logged in the wet season. The soil is fairly acid and low in fertility.

3. Climate.

The climate in Trinidad is described by Badcock (23) as typical of the insular tropics with a fairly heavy and well-distributed rainfall for some nine months in the year and a drier season for the remaining three months.

According to the climatic data recorded by the Imperial College of Tropical Agriculture, the mean values for 21 years (1929-49) are as below:

a. Mean annual maximum air temperature $86^\circ$F
b. Mean annual minimum air temperature 70.5°F

c. Soil temperature at 3" depth 81.5°F

d. Daily sunshine 7.3 hrs

e. Humidity, mean minimum 59%

f. Total rainfall per annum 67.8"

g. No. of rainy days (0.01") 226 days

h. Wind, 4.5 mls. per hr. in day

1.0 ml. per hr. in night.

4. Previous cropping.

<table>
<thead>
<tr>
<th>Bed No.</th>
<th>Year</th>
<th>Crop</th>
<th>Artificial fertilisers &amp; Manure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>May 1956–March 1957 Yams</td>
<td>50 lbs arti. fert and 3-1/3 tons of F.Y.M.</td>
<td></td>
</tr>
</tbody>
</table>


Mar. 1957–April 1957 Tobacco 34.5 lbs of arti. fert.

VI. NURSERY WORK.

1. Seed sowing.

Twelve wooden seed boxes were used for seed sowing. Each of these boxes was 30" long x 18" wide x 4" deep with openings uniformly provided in the bottom to allow adequate drainage. Dead bamboo leaves was placed over the slits of each seed box. The compost used consisted of two parts of bamboo soil and one part of well-rotted coconut fibre and was placed in each seed box up to about 1/2" from the top. No soil treatment or sterilisation was carried out because sufficient previous work has shown that bamboo soil obtained from an old bamboo plantation near the farm is free of soil borne diseases and weed seeds. One ounce of seed from one variety was sown by broadcasting in six boxes and one ounce from the other variety in the remaining six boxes. About 1/3" of sifted fine bamboo soil was used to cover the seeds after sowing. Watering was immediately given using a watering can with fine nozzles. The boxes were placed on benches under the open sided greenhouse. Hereafter, the seed boxes were watered each morning and afternoon in order to keep the soil in an adequate moist condition.

2. Seed germination.

Seeds started germinating two days after sowing and it was observed that germination was completed on the fourth day. The seed germinated very well although variety Succession showed slightly higher germinating percentage than Charleston Wakefield.

3. First transplanting.

Previous experience has shown that strong and vigorous
seedlings make better early growth in the field and final yields are increased. It was also found that transplanting the seedlings prior to setting them out in the field is a successful method of producing healthy seedlings. In this case, all cabbage seedlings were transplanted from the sowing boxes to another set of boxes when they were 7-10 days old. The size of boxes used were the same as those for sowing, but the compost used was composed of two parts of bamboo soil, one part of coconut fibre dust and 1/2 part of coarse sand. The purpose of using coconut fibre dust was to absorb moisture and to prevent drying out of the soil, while that the sand was to improve drainage. Thirty-six seed boxes were used and thus each variety was planted in eighteen of these boxes. Before transplanting, a layer of dead bamboo leaves was placed on the bottom of all boxes which were then filled up with the compost almost to the top.

Holes were marked out at a distance of 18" x 18" and therefore each box, sized 18" x 30" was planted with 240 seedlings approximately. The boxes were again placed under the open sided greenhouse.


The young delicate seedlings were managed carefully under the corrugated iron and glass roofed shed. In addition to disease control (see below) watering was done every day in order to keep the soil in a moist condition. The bamboo soil used in the seed boxes was considered to be fertile enough and therefore no fertiliser was added. Any additional nitrogenous fertiliser would probably have made the seedlings become too slender and over crowded in the boxes. No weeds grew among the seedlings and this again proved
that bamboo soil is free of weeds and suitable as a nursery soil.

Since the roofed shed of the greenhouse only allowed about 50% of sunlight to come through, the seedlings could not be properly hardened off. All boxes were therefore removed out into the open a week before final transplanting. During the hardening period, watering was also reduced from twice to once a day.

The seedlings grew well but downy mildew disease attacked them just before transplanting. This disease is worldwide in its occurrence on crucifers (24) and is the most destructive seedling disease of cabbage, cauliflower and broccoli in Florida (25). It is caused by the fungus *Peronospora parasitica*. The disease develops rapidly when night temperature range between 50° and 60°F for four nights in succession and when the plants remain wet until 10 to 11 o'clock in the morning (26). In Florida, Eddins (25, 26) found that the spores of the disease are scattered mainly by wind and rain and blow into new plant beds from diseased plants. In Trinidad, downy mildew has been found on almost all cabbage seedlings among growers but farmers rarely pay attention to its control and prevention. Seedlings are damaged to a varying extent but not long after they are set out in the field, the disease normally disappears naturally.

In this experiment, precaution was taken to prevent the attack. Therefore all seedlings up to seven days old were sprayed with 'Zineb' (65%) wettable powder at the rate of 1½ lbs in 100 gallons of water. Thereafter this was repeated three times a week until plants were set in the field. This method has been tested in Florida successfully (25) and is recommended to the cabbage growers (II).
The seedlings showed no symptoms of attack until two days before transplanting when some white moulds were found on the under sides of some leaves. No mould appeared on the petioles and stems of young seedlings and there was no sign of pale green, yellow or brown discoloration which is a common symptom of a bad attack of downy mildew. This attack was considered rather slight.

Apparently there were no insect pests attacking the young seedlings but when the boxes were removed out from the greenhouse and to the open for hardening a slight attack of ants was noticed.

About one month after sowing, the seedlings were approximately 3\(\frac{3}{4}\)" to 4" high with 4 - 5 true leaves and ready for transplanting in the field.
VII. FIELD WORK.

1. Preparation of Beds.

The beds had not been used for planting crops since October 1958, and weeds and grasses had covered the land during the rainy season. Before ploughing, the major part of these were cutlassed and removed. First ploughing was done a month before transplanting to a depth of about 10" by a double mouldboard plough drawn by a Ferguson tractor. The second machine operation took place two weeks afterwards which included a further ploughing, followed by discing with a disc harrow.

Each of the two big beds was divided into two blocks with a path of 6 ft. in between. Within a block, eight plots each 20 ft. x 12 ft. in size were sub-divided by one foot drains.

The heavy soil clods not broken down by the disc harrow were beaten down by rakes and weeding hoes. The idea was to prepare the land in the most suitable conditions for the growth of plants.

2. Application of fertiliser and Insecticide.

The Phosphate and Potash and half of the sulphate of ammonia was applied as basic fertiliser one week before transplanting. On the previous day to application, the fertiliser were weighed out and put into paper bags each labelled with a plot number. When applying, the bags were placed on their respective plots, the fertiliser inside mixed well and then spread evenly over the surface of the soil. Raking was done to incorporate the fertiliser into the soil.

To ensure greater success in transplanting, the holes...
Prior to transplanting, the whole field was sprayed with aldrin at the rate of 1:60. This precautionary measure was against soil inhabiting insects, particularly mole crickets, the most troublesome insects attacking young plants. They cause damage to plants by uprooting the young seedlings and they also feed upon the plants, often chewing off the stems at the soil surface and pulling the plants down into their burrows at night time. In the New College Farm, many kinds of newly-transplanted seedlings are damaged by mole crickets. During the warm moist weather, these insects seemed more active than under dry conditions.

3. Transplanting.

This operation was carried out on two days. On the first day, the sun was hot and the temperature was high and so planting was only done in the late afternoon after four o’clock. Experience has shown that in the tropics young plants should not be put out to the field during the period of 9.00 a.m. - 3.00 p.m but rather during the cooler evening time. On the second day, following some showers, the sky was overcast and planting was started earlier in the afternoon. Due to the shortage of labour, only block II was completed on the first day, but on the second day, more men were employed and all the other three blocks were completed before dark.

Holes on the experimental beds were marked out by using four strings each of them knotted at distances of 12", 15", 18" and 24" respectively. While marking, the ends of the strings were tied to bamboo pegs, driven into the ground at both sides of the beds. A digger was used to dig out holes of about 3" deep and 4" across at each knot along the string.

To ensure greater success in transplanting, the holes...
in the field were moderately soaked with water before the plants were set out. Furthermore the boxes themselves were given a thorough soaking, so that the soil would adhere to the roots of the plants. The seedlings were then lifted out from the seed boxes with a trowel carefully in order to retain a good ball of roots and soil. When planting, they were set deep enough so that the first leaves were almost touching the ground. The soil around the plant was made firm by using tips of the fingers to force out any air pockets. Thorough watering followed soon after the plants were set out.

4. Subsequent growth and Field Observation.

a. Irrigation.

The weather was absolutely dry after the completion of transplanting. Unfortunately the overhead sprinkler system was unable to operate due to a breakdown of the pump, and irrigation of the young plants could only be done by hand watering. This laborious method did not supply sufficient moisture to the crop during the period of early growth but gave just enough to prevent the plants reaching their permanent wilting points. This unsatisfactory watering lasted for a week before artificial irrigation was applied. For the first few weeks, approximately 1" of water was given in two applications rather than one. This was done because it was felt that cabbage at this period of growth possesses only shallow small roots and that rapid loss of this water might occur from evaporation before the plants could absorb it. After this, only one application was given.

The growth of plants was completely changed after the soil had been well saturated. It should be emphasized here that water supply is essential in the cultivation of cabbage particularly in the early stages.

When the heads began to form and during the final matur-
ing period irrigation water was applied only once a week at a rate equivalent to about $\frac{1}{2}''$ to $\frac{1}{2}''$ of rain. Heavy supply of moisture at this period was considered not beneficial since it was possible that the well developed heads might burst.

b. Supplying of missing plants:

Dead plants, lost by inadequate watering or damaged by mole crickets, were supplied for the first eight days only. The total number of supplies was finally counted; 201 plants of which thirty-nine were in block I, forty-eight in II, fifty-five in III and fifty-nine plants in block IV. Percentage of supplies in proportion to the total number of experimental plants was less than 7% which was rather small.

c. Cultivation and Weeding:

Cultivating by hand fork was done twice during the growing period. The main object was to keep down weeds and to preserve a fine tilth until the crop reached a sufficient size to cover the land. As the roots of cabbage spread in the top 2'' of the surface soil only, shallow cultivation was attempted. Plants in the wider spaced plots (18'' & 24'' apart) covered the ground less quickly than the closer spaced plots (12'' & 15'') and for this reason a further weeding was necessary for them. Moulding or earthing up the plants was done at the time of weeding.

d. Top dressing of fertiliser:

The other half of the sulphate of ammonia was applied as a top dressing to the treated plots about a month after transplanting. Plants started to head at this stage and the application of a nitrogenous
fertiliser is beneficial to their formation (3). The method of carrying out this application was the same as in the first application. The fertiliser was applied by hand as a side dressing in a band around the plants, 3" away.

6. Pest control

To control the bud worms, the cabbage white butterflies and leaf miners and possible pests which might occur, the new insecticide 'Trithion' was used. This insecticide has been used by the sugar estates in Trinidad to prevent and to control sugar cane frog hoppers with success. It was reported that the residual effect lasted longer than any other insecticides available on the market.

All the seedlings in the nursery were sprayed before transplanting at the concentration of 3 c.c. per gallon of water. After transplanting, the same treatment was given regularly once a week by knapsack sprayer. Satisfactory results were obtained and throughout the whole growing period no serious damage occurred, and there were only a limited number of white butterfly larvae seen. These larvae did a slight damage to the outer leaves of the plants only and it was considered not important.

Bachac ants were found in large numbers near the Eastern edge of Bed No:23, Plot No:1. It was observed that a few young cabbage plants in this bed had been eaten particularly at the growing point and the younger part of the plants. Damage was done only along the discard row. The ants were controlled by pouring into the nest a strong solution of 'chlordane' (1 pt. in 4 gals. of water.)

For the sake of safety to consumers, the spraying of
'Trithion' was discontinued two weeks before the harvesting of the crop.

f. Disease:

As far as diseases were concerned, no preventive measures were taken because:

i. The land had not been used for growing cabbage or any other crops belonging to the Cruciferae family in the previous three years,

ii. the experimental plot was far away from the main cabbage growing area and

iii. no disease was found to be of importance to the crop amongst peasant farmers.

About ten days after transplanting, some plants had wilted and died suddenly. The outer tissues of the stem just below the surface soil level had shrivelled, become water-soaked and turned brown to black. Before the wilting, no symptoms were noticed.

Dead plants were examined by the pathologist of the College and the damage was identified as being done due to Rhizoctonia disease (Pellicularia filamentosa). This fungus is widely distributed in the soil and attacks a great many species of plants and cause a variety of pathological effects (27). In Florida where Rhizoctonia is a common disease of vegetable crops including cabbage, cauliflower and other crucifers, Eddins (26) mentions that the cabbage strain of Rhizoctonia grows at temperatures ranging between 48° and 91° F but experiments demonstrated that the optimum temperatures for infection of cabbage are 77° to 80°F. He found that the fungus invades the plant through non-injured tissues or through wounds, provided enough moisture is present to permit it to grow on the tissues long enough to enter them. Banking soil around plants and covering parts of...
leaves with soil when cultivating the crop create conditions favourable for development of stalk and head rot (23).

Apparently no thoroughly effective method for controlling the disease is known (26) but when the disease is troublesome outdoors, Walker (24) suggests to drench the bases of the plants with 1:2,000 mercuric chloride solution. Following Walker's suggestion mercuric chloride was applied and in addition to this application, irrigation and drainage was undertaken carefully to avoid favourable conditions for further infection. Even with these measures, the disease had not been completely checked and death of plants occurred nearly daily till February 18th, 1959. As soon as wilting was found the whole plant was removed from the plot and record was taken weekly of the number of deaths, which at final count was 205, that is about 7% of the total experimental plants. No difference of susceptibility was found between the varieties and fertiliser treatments. The record in detail is shown in Appendix No:6.

g. Observation of plant growth:

In general, the crop grew extremely well and there were no losses other than those from rhizoctonia. Observations were made regularly throughout the growing period and it was found that subsequent growth varied greatly between different treatments.

In the wider spacings, treated with fertilisers, particularly sulphate of ammonia, all plants grew vigorously, strong, healthy and with a deep green colour. The widest spacing (24" x 24") produced the largest plants but they were unable to build up sufficient cover to suppress weeds. On the other hand, with the closer spacings, the plants grew smaller but covered the ground quicker. In the narrowest
spacing (12" x 12") particularly where no nitrogenous fertiliser was
given, the plants were stunted, over crowded and as a result, all
appeared weak, pale green to yellowish in colour, typical symptoms
of Nitrogen deficiency. From this observation, Nitrogen seemed
the most essential nutrient for the crop. Not only was the growth
rate affected but there was also a delay or even failure in forming
heads.

An interaction between population of plants and Nitrogen
was clearly shown in plant growth. The effect of nitrogen was not
nearly so marked in the wider as in the closer spacings. Plants in
the wider spacings even with no Nitrogen, still showed up fairly well
and looked much better than those in the high population or close spaced
plots.

The effect of phosphatic fertiliser made no obvious
difference in relation to the plant growth.

With regard to the two varieties, Succession seemed to produce
larger sized plants but started to form heads later than Charleston
Wakefield. On the other hand, the Charleston Wakefield produced
firmer and more solid heads.

As to the four spacings, there appeared to be too much room
available for both varieties, at the widest spacing of S4 (24" x 24"),
yet there was not sufficient space for plant development at the closest
spacings S1 (12" x 12" and 15" x 15").

Based on field observations alone, it was concluded that
variety Charleston Wakefield at a spacing of 18" x 18" treated with
4 cwts or more of sulphate of ammonia per acre gave best results.
5. **Harvesting.**

The first harvest took place on March 6th, 1959, the sixty-sixth day after transplanting. The aim was to choose those which had reached maximum size with adequate firmness and solidity. When harvesting, the cabbage head was bent slightly and it was cut off with a knife. A plot was harvested at a time and during this operation, the discards were cut first before the experimental plants.

In order to obtain accurate weight, each experimental plant was weighed individually for the gross weight first, then the outside leaves were peeled off leaving only two as wrappers to protect the head, which was regarded as a marketable cabbage head. This head was weighed again in a similar manner. Soon after the weighing, both the gross and marketable weights were entered into the harvesting record sheet respectively.

Two to three harvests were made every week and there were ten harvests during the period of approximately one month.
1. Yields per unit area.

   a. Marketable weight:

   Yields of marketable heads per unit area are given in Appendix 3a. The graph of yields and plant populations per acre is given in Appendix 5a. The analysis of variance is shown in Appendix 4 of this report.

   The coefficient of variation was only 9.8% indicating a carefully conducted and successful experiment.

   Comparing the two varieties, Charleston Wakefield (V1) and Succession (V2), no statistical differences were found. It is probably that, under the local conditions, both varieties could produce approximately equal yields if similar treatments are given.

   Spacing had the greatest effect in this experiment. Close spacing, although it reduced the average weight per head, considerably increased the acre yield. Of all the four spacings studied in this experiment, the yields of the closer spacings (S1 12" x 12", S2 15" x 15" and S3 18" x 18") were significantly higher than that of the widest one (24" x 24"), at the 1% level.

   No significance was found between S1, S2 and S3. This was unexpected and the reason might be that there was a high percentage of plants in the closer spacings that failed to form heads because overcrowding. Discussion is dealt later in this report.

   Whilst there was no significant effect of variety, Charleston Wakefield appeared to tolerate closer spacing more than Succession. The reason might be explained that the growing habit of Charleston Wakefield tends to be more erect and it needs less space for development. On the other hand, Succession is a spreading type and its outer leaves are bulky and therefore it does not like the closer spacings.
As stated in the field observation report, the crop responded well to nitrogen. This statement had been confirmed by the analysis of results. Here nitrogen at 4 cwt per acre gave a 34.5% extra yield over no nitrogen and this was significant at the 1% level.

With regard to the interactions, there was a significantly greater response to nitrogen at the closer spacings, as would, in fact, be expected. This was observed during the growing period. It is therefore important to apply more nitrogenous fertilisers if the plants are closely spaced.

There were no interactions between nitrogen and varieties and nitrogen and phosphorus. Also, there were no interactions between phosphorus and varieties.

Generally, no response to phosphorus was found but there was a large response to phosphorus at the widest spacing and this must be attributable to experimental error.

b. Gross weight:

The gross yields of all heads are given in Appendix 3b and the graph of yields and plant populations per acre is shown in Appendix 5a. No statistical analysis was done on them as the gross yields have no economic importance in cabbage growing in Trinidad.

Here again, closer spacings of $S_1$, $S_2$ and $S_3$ gave marked increases in gross weight over that obtained from the widest one, $S_4$. The response to nitrogen was also high. In general, variety Succession had much higher gross yields than Charleston Wakefield.
2. Yields per plant.

Data for the average weight per plant of both the gross and marketable yields are given in Appendix 3b and the graph showing the relationship between yield per plant and plant population appears in Appendix 5b.

It is apparent from the graph that there was no difference at all between variety V1, Charleston Wakefield and V2, Succession, as far as marketable yields were concerned, even though V2 increased the gross weight per plant in the wider spacings S3 and S4.

As might be expected, close spacing greatly reduced the average head size in both varieties. In V1, plants spaced 24" apart produced marketable heads which weighed 3.10 lbs as compared with 2.26 lbs., 1.70 lbs, and 1.06 lbs for heads produced at the 18", 15" and 12" spacings respectively. For similar spacings in V2, the order of average weight per head was 3.24 lbs, 2.30 lbs, 1.50 lbs and 1.12 lbs.

In general, the housewife in Trinidad prefers relatively small heads of cabbage and the average head size which weighs about 1-1.5 lbs is most saleable in the local market. Hence, market gardeners should consider to adjust their spacings in order to produce suitable size of cabbage for the market.

Nitrogen, in general, increased the average head size of cabbage in both varieties but no response to phosphorus was found.

3. Percentage of marketable heads in relation to spacing:

In Appendix 3C, it is shown that the percentage of marketable heads was greatly affected by the spacings. Summary of this result is given below:

1. Charleston Wakefield

Spacing at 12" x 12" gave 91% of marketable heads
 " 15" x 15"  " 94%  "  "  

- 38 -
1. Charleston Wakefield

Spacing at 18" x 18" gave 100% of marketable heads

" " 24" x 24" " 100% " "

2. Succession*

Spacing at 12" x 12" gave 82% of marketable heads

" " 15" x 15" " 96% " "

" " 18" x 18" " 100% " "

" " 24" x 24" " 100% " "

It is obvious that the plants in the wider spacings had much better chances to mature up to marketable size. In the closer spacings, the plant population was so high that there was no sufficient room for the plants to develop and as a result a considerable amount of plants were stunted and failed to form heads.

In comparing the two varieties, 94.3% of heads in Charleston Wakefield succeeded in forming marketable heads whilst in the Succession this figure was markedly lower, 90.2%.

4. Time of maturity in relation to spacing:

In addition to the head size, spacing may also affect the time of maturation. Concerning this factor, a record in detail is found in Appendix 3C and the summary is given on page 40.

From the record on page 40, it is shown that the wider spaced plants of both varieties reached maturity earlier than the closer spaced ones. It is therefore concluded that if the plants are spaced too close, not only the size of heads is reduced but also maturity is delayed.
Charleston from planting to harvesting.

<table>
<thead>
<tr>
<th>Charleston Wakefield</th>
<th>66-70 days</th>
<th>72-77 days</th>
<th>78-83 days</th>
<th>91-96 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot; x 12&quot;</td>
<td>9.7%</td>
<td>26.7%</td>
<td>32.2%</td>
<td>30.8%</td>
</tr>
<tr>
<td>15&quot; x 15&quot;</td>
<td>13.7%</td>
<td>36.0%</td>
<td>33.2%</td>
<td>17.1%</td>
</tr>
<tr>
<td>18&quot; x 18&quot;</td>
<td>17.9%</td>
<td>38.4%</td>
<td>29.0%</td>
<td>14.7%</td>
</tr>
<tr>
<td>24&quot; x 24&quot;</td>
<td>30.4%</td>
<td>41.8%</td>
<td>22.6%</td>
<td>5.2%</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>14%</strong></td>
<td><strong>32.6%</strong></td>
<td><strong>31.3%</strong></td>
<td><strong>22.1%</strong></td>
</tr>
</tbody>
</table>

Succession

<table>
<thead>
<tr>
<th>Succession</th>
<th>12&quot; x 12&quot;</th>
<th>15&quot; x 15&quot;</th>
<th>18&quot; x 18&quot;</th>
<th>24&quot; x 24&quot;</th>
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<tbody>
<tr>
<td>12&quot; x 12&quot;</td>
<td>3.7%</td>
<td>16.1%</td>
<td>37%</td>
<td>43.2%</td>
</tr>
<tr>
<td>15&quot; x 15&quot;</td>
<td>5.4%</td>
<td>20.8%</td>
<td>32.7%</td>
<td>41.1%</td>
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<tr>
<td>18&quot; x 18&quot;</td>
<td>11.3%</td>
<td>22.5%</td>
<td>33.3%</td>
<td>32.9%</td>
</tr>
<tr>
<td>24&quot; x 24&quot;</td>
<td>20.3%</td>
<td>33.0%</td>
<td>34.0%</td>
<td>12.7%</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>7.1%</strong></td>
<td><strong>20.1%</strong></td>
<td><strong>34.8%</strong></td>
<td><strong>38%</strong></td>
</tr>
</tbody>
</table>

Charleston Wakefield generally headed earlier than Succession and it was found from this experiment that about half of the total heads in the first variety were harvested in the first ten days but only 27% from the second variety. This confirms the seedsman's statements, that even under Trinidad conditions, that Charleston Wakefield is an earlier variety than Succession.

5. Percentage of waste (outleaf):

In cabbage growing, a certain amount of waste is produced and the percentage of such waste is probably determined by the variety used, the spacing and the fertiliser applied. In this experiment, variety Succession gave a higher percentage of waste than that of the Charleston Wakefield. As a result, Succession did not give significant
higher marketable yields per unit area, though significance might have been shown if analysis was applied to gross weight figures.

Among all spacings in Charleston Wakefield the closest one, S1 (12" x 12") gave 35.3% of waste which was the highest, whilst in the fertiliser levels the application of NnP produced the heaviest heads but on the other hand, a higher percentage of waste (39%) occurred.

No obvious distinction was found between all treatments in the variety Succession on this particular subject.

Record below shows the percentage of waste in detail.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Charleston Wakefield</th>
<th>Succession</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total wt/ mark wt/plant</td>
<td>Total wt/ mark wt/plant</td>
</tr>
<tr>
<td></td>
<td>lb.</td>
<td>%</td>
</tr>
<tr>
<td>S1</td>
<td>6.54</td>
<td>4.23</td>
</tr>
<tr>
<td>S2</td>
<td>9.95</td>
<td>6.80</td>
</tr>
<tr>
<td>S3</td>
<td>13.17</td>
<td>9.05</td>
</tr>
<tr>
<td>S4</td>
<td>18.38</td>
<td>12.40</td>
</tr>
<tr>
<td>nil N &amp; P</td>
<td>10.79</td>
<td>7.24</td>
</tr>
<tr>
<td>N</td>
<td>12.06</td>
<td>8.16</td>
</tr>
<tr>
<td>P</td>
<td>11.31</td>
<td>7.61</td>
</tr>
<tr>
<td>NP</td>
<td>13.88</td>
<td>9.47</td>
</tr>
</tbody>
</table>
RECOMMENDATIONS.

This experiment has been a very interesting one and it is recommended that further trials be carried out in Trinidad to confirm its results. With the experience obtained from this trial, several points are suggested for the reference of future workers.

1. In this experiment, only two popular varieties were used. There are a number of other cabbage varieties which the Trinidadian farmers are growing in their gardens. There is lack of information on the characteristics and adaptabilities of these varieties. It would therefore appear necessary to run further experiments on a broader scale; to compare the varieties, spacings and fertiliser levels.

2. Though cabbages grow extremely well in the dry season of Trinidad it is likely that they could thrive quite well too in the wet season under proper management, particularly the prevention and control of insects. To find out the best cultivation methods, the most suitable varieties, the proper spacings and adequate fertilisers for the wet season would benefit greatly the market gardeners in Trinidad.

3. With regard to spacing, a distance of 2 ft apart is definitely too wide for the cabbage in this hot tropical climate. The spacings recommended for future trials are
12", 14", 16" and 18" either way.

4. Under the local conditions, nitrogen seemed the most essential nutrient for the crop. It is quite possible that cabbage would respond to extra nitrogenous fertiliser than the amount which was applied in this experiment. It is therefore considered that four levels of Sulphate of ammonia at the rate of 0 cwt, 2 cwt, 4 cwt and 6 cwt, per acre might be tried.

5. Even though phosphorus affects the growth of the crop in the cool temperate regions it did not show any response in this experiment. It is suggested that comparison of this fertiliser could be omitted in future trials.
REFERENCES


   "Cabbage Production Guide."

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   "The Cultivation of Vegetable Crops."
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17. Lingle, J.C. (1958),
    College of Agri. University of California, U.S.A.
    Private Contact.

    "Vegetable Growing."
    Lea & Febiger, Phil. U.S. A.

    "Effect of different sources of fertiliser nutrients and different rates of fertiliser applications on yields of vegetable canning crops, Beets, Cabbage, Peas, Sweet corn and Tomato."

    "Vegetables - Fresh Market"
    U.S. Department of Agriculture, Agri. Marketing Service Crop Reporting Board.

22. Chenery, E.M. (1952) "Soils of Central Trinidad".


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### Calendar of Cultural Operations

#### 1958

<table>
<thead>
<tr>
<th>Date</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov. 28</td>
<td>Sowing of seed.</td>
</tr>
<tr>
<td>Dec. 1</td>
<td>1st. ploughing and discing field no. 22 and 23.</td>
</tr>
<tr>
<td>Dec. 5</td>
<td>Spraying of seedling with 'Zineb' three times a week, from today until Dec. 28th, 1959.</td>
</tr>
<tr>
<td>6</td>
<td>1st transplanting seedling, var. 'Succession'.</td>
</tr>
<tr>
<td>8</td>
<td>1st transplanting seedling, var. 'Charleston Wakefield'.</td>
</tr>
<tr>
<td>17</td>
<td>2nd. ploughing and discing field no. 22 and 23.</td>
</tr>
<tr>
<td>22-23</td>
<td>Preparation of experimental bed.</td>
</tr>
<tr>
<td>22</td>
<td>Mixing and weighing fertiliser.</td>
</tr>
<tr>
<td>22</td>
<td>Spraying seedling with 'lead of arsenic'.</td>
</tr>
<tr>
<td>23</td>
<td>Applying basic fertiliser.</td>
</tr>
<tr>
<td>29</td>
<td>Applying 'aldrin' to the experimental bed.</td>
</tr>
<tr>
<td>29</td>
<td>Spraying all seedlings with 'Trithion' insecticide.</td>
</tr>
<tr>
<td>29</td>
<td>Final transplanting block no. 11</td>
</tr>
<tr>
<td>30</td>
<td>Final transplanting block No. L, III &amp; IV</td>
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</table>

#### 1959

<table>
<thead>
<tr>
<th>Date</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 2-8</td>
<td>Supplying of missing plants.</td>
</tr>
<tr>
<td>5</td>
<td>Spraying with 'Trithion' in the field.</td>
</tr>
<tr>
<td></td>
<td>(Once a week from now on until two weeks before harvesting)</td>
</tr>
<tr>
<td>7</td>
<td>1st application of artificial irrigation.</td>
</tr>
<tr>
<td></td>
<td>(twice a week from today till Feb. 2nd., then once a week was applied)</td>
</tr>
<tr>
<td>12-13</td>
<td>1st. cultivation and weeding.</td>
</tr>
<tr>
<td>19</td>
<td>Spraying of 'mercuric chloride'.</td>
</tr>
<tr>
<td>31</td>
<td>2nd Cultivation and weeding.</td>
</tr>
<tr>
<td>Feb. 2</td>
<td>Top dressing of sulphate of ammonia.</td>
</tr>
<tr>
<td>16</td>
<td>Hand weeding.</td>
</tr>
<tr>
<td>Mar. 6</td>
<td>First harvesting.</td>
</tr>
<tr>
<td>Apr. 6</td>
<td>Last harvesting.</td>
</tr>
</tbody>
</table>
**APPENDIX 2 (a)**

Design of Experiment.


(a) **Combination of treatments.**

<table>
<thead>
<tr>
<th>Block I</th>
<th>Block II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>ac</td>
</tr>
<tr>
<td>ae</td>
<td>ce</td>
</tr>
<tr>
<td>abc</td>
<td>b</td>
</tr>
<tr>
<td>bce</td>
<td>abe</td>
</tr>
<tr>
<td>acd</td>
<td>d</td>
</tr>
<tr>
<td>cde</td>
<td>ade</td>
</tr>
<tr>
<td>bd</td>
<td>abcd</td>
</tr>
<tr>
<td>abde</td>
<td>bode</td>
</tr>
</tbody>
</table>

(b) **Order of blocks by randomization.**

<table>
<thead>
<tr>
<th>Block III</th>
<th>Block IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>c</td>
</tr>
<tr>
<td>e</td>
<td>ace</td>
</tr>
<tr>
<td>bo</td>
<td>ab</td>
</tr>
<tr>
<td>abce</td>
<td>be</td>
</tr>
<tr>
<td>cd</td>
<td>ad</td>
</tr>
<tr>
<td>acde</td>
<td>de</td>
</tr>
<tr>
<td>abd</td>
<td>bcd</td>
</tr>
<tr>
<td>bde</td>
<td>abode</td>
</tr>
</tbody>
</table>

(c) **Randomization of treatments within blocks.**

<table>
<thead>
<tr>
<th>Block III</th>
<th>Block I</th>
</tr>
</thead>
<tbody>
<tr>
<td>aode</td>
<td>bd</td>
</tr>
<tr>
<td>abd</td>
<td>ae</td>
</tr>
<tr>
<td>e</td>
<td>abde</td>
</tr>
<tr>
<td>abce</td>
<td>bce</td>
</tr>
<tr>
<td>bde</td>
<td>abc</td>
</tr>
<tr>
<td>cd</td>
<td>(i)</td>
</tr>
<tr>
<td>bc</td>
<td>aod</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Block IV</th>
<th>Block II</th>
</tr>
</thead>
<tbody>
<tr>
<td>be</td>
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</tr>
<tr>
<td>c</td>
<td>b</td>
</tr>
<tr>
<td>ace</td>
<td>abe</td>
</tr>
<tr>
<td>ab</td>
<td>ac</td>
</tr>
<tr>
<td>bod</td>
<td>abod</td>
</tr>
<tr>
<td>ad</td>
<td>d</td>
</tr>
<tr>
<td>abode</td>
<td>ce</td>
</tr>
<tr>
<td>de</td>
<td>bode</td>
</tr>
</tbody>
</table>
### Field Layout of Experiment

#### Bed A.

<table>
<thead>
<tr>
<th>Path</th>
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<tbody>
<tr>
<td>(24)</td>
<td>S2V2NP</td>
</tr>
<tr>
<td>(23)</td>
<td>S4V1N</td>
</tr>
<tr>
<td>(22)</td>
<td>S1V1P</td>
</tr>
<tr>
<td>(21)</td>
<td>S2V1</td>
</tr>
<tr>
<td>(20)</td>
<td>S4V2P</td>
</tr>
<tr>
<td>(19)</td>
<td>S3V1NP</td>
</tr>
<tr>
<td>(18)</td>
<td>S1V2N</td>
</tr>
<tr>
<td>(17)</td>
<td>S3V2</td>
</tr>
</tbody>
</table>

#### Bed B.

<table>
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<tr>
<th>Path</th>
<th>BLOCK IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>(32)</td>
<td>S3V1P</td>
</tr>
<tr>
<td>(31)</td>
<td>S1V2</td>
</tr>
<tr>
<td>(30)</td>
<td>S2V2P</td>
</tr>
<tr>
<td>(29)</td>
<td>S4V1</td>
</tr>
<tr>
<td>(28)</td>
<td>S3V2N</td>
</tr>
<tr>
<td>(27)</td>
<td>S2V1N</td>
</tr>
<tr>
<td>(26)</td>
<td>S4V2NP</td>
</tr>
<tr>
<td>(25)</td>
<td>S1V1NP</td>
</tr>
</tbody>
</table>

#### Path

<table>
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<tbody>
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<tr>
<td>(7)</td>
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</tr>
<tr>
<td>(6)</td>
<td>S4V1NP</td>
</tr>
<tr>
<td>(5)</td>
<td>S1V2NP</td>
</tr>
<tr>
<td>(4)</td>
<td>S3V2P</td>
</tr>
<tr>
<td>(3)</td>
<td>S4V2</td>
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<tr>
<td>(2)</td>
<td>S1V1</td>
</tr>
<tr>
<td>(1)</td>
<td>S2V2N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BLOCK II</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>(16)</td>
<td>S2V1NP</td>
</tr>
<tr>
<td>(15)</td>
<td>S3V1</td>
</tr>
<tr>
<td>(14)</td>
<td>S4V1P</td>
</tr>
<tr>
<td>(13)</td>
<td>S2V2</td>
</tr>
<tr>
<td>(12)</td>
<td>S4V2N</td>
</tr>
<tr>
<td>(11)</td>
<td>S1V1N</td>
</tr>
<tr>
<td>(10)</td>
<td>S1V2P</td>
</tr>
<tr>
<td>(9)</td>
<td>S3V2NP</td>
</tr>
</tbody>
</table>

**River** E. N.
<table>
<thead>
<tr>
<th>Block I</th>
<th>Treatment</th>
<th>No. of Plants</th>
<th>No. of Plants transplanted</th>
<th>Plot Yields per plant in lbs</th>
<th>Yield per 100 lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$S_2V_2N$</td>
<td>98</td>
<td>91</td>
<td>142.5</td>
<td>1.56</td>
</tr>
<tr>
<td>2</td>
<td>$S_1V_1$</td>
<td>180</td>
<td>160</td>
<td>137.75</td>
<td>0.86</td>
</tr>
<tr>
<td>3</td>
<td>$S_4V_2$</td>
<td>32</td>
<td>31</td>
<td>76.25</td>
<td>2.46</td>
</tr>
<tr>
<td>4</td>
<td>$S_3V_2P$</td>
<td>66</td>
<td>60</td>
<td>122.25</td>
<td>2.04</td>
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<tr>
<td>5</td>
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<td>180</td>
<td>146</td>
<td>190.5</td>
<td>1.43</td>
</tr>
<tr>
<td>6</td>
<td>$S_4V_1NP$</td>
<td>32</td>
<td>31</td>
<td>109.5</td>
<td>3.53</td>
</tr>
<tr>
<td>7</td>
<td>$S_2V_1P$</td>
<td>98</td>
<td>75</td>
<td>102.75</td>
<td>1.37</td>
</tr>
<tr>
<td>8</td>
<td>$S_3V_1N$</td>
<td>66</td>
<td>62</td>
<td>133.75</td>
<td>2.16</td>
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</tbody>
</table>

<table>
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<th>No. of Plants</th>
<th>No. of Plants transplanted</th>
<th>Plot Yields per plant in lbs</th>
<th>Yield per 100 lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>$S_3V_2NP$</td>
<td>66</td>
<td>55</td>
<td>133.75</td>
<td>2.43</td>
</tr>
<tr>
<td>10</td>
<td>$S_1V_2P$</td>
<td>180</td>
<td>145</td>
<td>149</td>
<td>1.03</td>
</tr>
<tr>
<td>11</td>
<td>$S_1V_1N$</td>
<td>180</td>
<td>171</td>
<td>207.25</td>
<td>1.21</td>
</tr>
<tr>
<td>12</td>
<td>$S_4V_2N$</td>
<td>32</td>
<td>31</td>
<td>101.25</td>
<td>3.27</td>
</tr>
<tr>
<td>13</td>
<td>$S_2V_2$</td>
<td>98</td>
<td>93</td>
<td>124</td>
<td>1.33</td>
</tr>
<tr>
<td>14</td>
<td>$S_4V_1F$</td>
<td>32</td>
<td>27</td>
<td>86</td>
<td>3.19</td>
</tr>
<tr>
<td>15</td>
<td>$S_3V_1$</td>
<td>66</td>
<td>61</td>
<td>127.25</td>
<td>2.09</td>
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<tr>
<td>16</td>
<td>$S_2V_1NP$</td>
<td>98</td>
<td>90</td>
<td>182.75</td>
<td>2.03</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Block III</th>
<th>Treatment</th>
<th>No. of Plants</th>
<th>No. of Plants transplanted</th>
<th>Plot Yields per plant in lbs</th>
<th>Yield per 100 lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>$S_3V_2$</td>
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<td>51</td>
<td>115.25</td>
<td>2.26</td>
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<td>18</td>
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<td>133</td>
<td>166.5</td>
<td>1.21</td>
</tr>
<tr>
<td>19</td>
<td>$S_3V_1NP$</td>
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<td>57</td>
<td>146.5</td>
<td>2.57</td>
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<td>20</td>
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<td>27</td>
<td>79.25</td>
<td>2.93</td>
</tr>
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<td>21</td>
<td>$S_2V_1$</td>
<td>98</td>
<td>82</td>
<td>105</td>
<td>1.28</td>
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<tr>
<td>22</td>
<td>$S_1V_1P$</td>
<td>180</td>
<td>144</td>
<td>118</td>
<td>0.82</td>
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<tr>
<td>23</td>
<td>$S_4V_1N$</td>
<td>32</td>
<td>31</td>
<td>82.75</td>
<td>2.67</td>
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<td>24</td>
<td>$S_2V_2NP$</td>
<td>98</td>
<td>76</td>
<td>151.75</td>
<td>2.00</td>
</tr>
<tr>
<td>Plot No.</td>
<td>Treatments</td>
<td>No. of plants transplanted</td>
<td>No. of plants harvested</td>
<td>Plot yield per plant in lbs</td>
<td>Yield per acre in 100 lbs</td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
<td>-----------------------------</td>
<td>-------------------------</td>
<td>-----------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Block IV</td>
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<td></td>
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<td>25</td>
<td>S1V1NP</td>
<td>180</td>
<td>153</td>
<td>205.25</td>
<td>1.34</td>
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<td>26</td>
<td>S4V2NP</td>
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<td>29</td>
<td>124.5</td>
<td>4.29</td>
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<td>27</td>
<td>S2V1N</td>
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<td>82</td>
<td>174</td>
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<td>28</td>
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<td>65</td>
<td>161</td>
<td>2.47</td>
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<td>29</td>
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<td>75.25</td>
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<td>95</td>
<td>106.5</td>
<td>1.12</td>
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<td>S1V2</td>
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<td>123.75</td>
<td>0.91</td>
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<td>S3V1P</td>
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<td>65</td>
<td>144.75</td>
<td>2.23</td>
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<tr>
<td>Total:</td>
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<td></td>
<td></td>
<td>3098</td>
<td>2,585</td>
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</table>

**Remarks:**

Actual yield data in terms of pounds harvested per plot have been transferred into standard unit in 100 lbs/acre. The following factors were applied.

<table>
<thead>
<tr>
<th>Spacing</th>
<th>Harvested plot size</th>
<th>Factor 100 lbs/ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1 12&quot; x 12&quot;</td>
<td>180 sq. ft.</td>
<td>2.420</td>
</tr>
<tr>
<td>S2 15&quot; x 15&quot;</td>
<td>153 &quot;</td>
<td>2.847</td>
</tr>
<tr>
<td>S3 18&quot; x 18&quot;</td>
<td>148.5 &quot;</td>
<td>2.933</td>
</tr>
<tr>
<td>S4 24&quot; x 24&quot;</td>
<td>128 &quot;</td>
<td>3.403</td>
</tr>
</tbody>
</table>
## APPENDIX 3 (b)

### Individual plot yield (gross wt.)

<table>
<thead>
<tr>
<th>Plot No.</th>
<th>Treatment</th>
<th>No. of plants</th>
<th>No. of plants transplanted</th>
<th>Plot yield in lbs.</th>
<th>Yield per plant in lbs.</th>
<th>Yield per acre in 100 lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>S₂V₂  N</td>
<td>98</td>
<td>91</td>
<td>232</td>
<td>2.55</td>
<td>661</td>
</tr>
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<td>2</td>
<td>S₁V₁</td>
<td>180</td>
<td>174</td>
<td>243</td>
<td>1.39</td>
<td>588</td>
</tr>
<tr>
<td>3</td>
<td>S₄V₂</td>
<td>32</td>
<td>31</td>
<td>123</td>
<td>3.97</td>
<td>419</td>
</tr>
<tr>
<td>4</td>
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<td>Yield per plant in lbs</td>
<td>Yield per acre in 100 lbs</td>
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Remarks:—

Actual yield data in terms of pounds harvested per plot have been transferred into standard unit in 100 lbs/acre. Factors applied are shown in Appendix 3a.
**APPENDIX 3 (c)**

RECORD SHOWING PERCENTAGE OF MARKETABLE HEADS AND DATE OF HARVESTING BASED ON SPACING.

<table>
<thead>
<tr>
<th>TREATMENT</th>
<th>Total No. of plants transplanted on 18/2/59</th>
<th>No. of marketable heads harvested</th>
<th>Harvesting in relation to number of days required from planting to harvesting.</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
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<td>Charleston Wakefield</td>
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<tr>
<td>12&quot; x 12&quot;</td>
<td>720</td>
<td>690</td>
<td>628</td>
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<td>15&quot; x 15&quot;</td>
<td>392</td>
<td>346</td>
<td>328</td>
</tr>
<tr>
<td>18&quot; x 18&quot;</td>
<td>264</td>
<td>245</td>
<td>245</td>
</tr>
<tr>
<td>24&quot; x 24&quot;</td>
<td>128</td>
<td>118</td>
<td>118</td>
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<tr>
<td>Total &amp; Mean:</td>
<td>1,504</td>
<td>1,396</td>
<td>1,316</td>
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Succession

<table>
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<th>No. of marketable heads harvested</th>
<th>Harvesting in relation to number of days required from planting to harvesting.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>12&quot; x 12&quot;</td>
<td>720</td>
<td>686</td>
<td>565</td>
</tr>
<tr>
<td>15&quot; x 15&quot;</td>
<td>392</td>
<td>371</td>
<td>355</td>
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<td>18&quot; x 18&quot;</td>
<td>264</td>
<td>232</td>
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<tr>
<td>24&quot; x 24&quot;</td>
<td>128</td>
<td>118</td>
<td>118</td>
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<td>Total &amp; Mean:</td>
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<td>1,269</td>
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i.e. 92.8%  
i.e. 93.5%
# APPENDIX 4

## ANALYSIS OF VARIANCE FOR MARKETABLE YIELDS PER PLOT
(In terms of yield in 100 lbs/acre)

<table>
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<tr>
<th>Sources of variation</th>
<th>D.F.</th>
<th>S.S.</th>
<th>M.S.</th>
<th>F</th>
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<td>Treatments</td>
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<tr>
<td>(Main effects)</td>
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<td></td>
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<tr>
<td>1st order interactions</td>
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<td>165,889</td>
<td>9,216</td>
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<td>31</td>
<td>193,752</td>
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S.E. of 1 plot = \( \sqrt{1335} \) = 36.55

Plot mean 372

Coefficient of variation = 9.8%

### Notation

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<tr>
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<th>a</th>
<th>b</th>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>( S_2(a) )</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>( S_3(b) )</td>
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<td>1</td>
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<tr>
<td>( S_4(ab) )</td>
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<td>1</td>
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<tr>
<td>Varieties (V)</td>
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<td>1</td>
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<tr>
<td>Nitrogen (N)</td>
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<td>Phosphorus (P)</td>
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### Partition of sum of squares:

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<td><strong>1st Order Interactions</strong></td>
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<td>27354</td>
</tr>
<tr>
<td><strong>Partition of Error</strong></td>
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<td>13352</td>
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</table>

#### Main

| A          | 18145 |
| B          | 8192  |
| AB         | 11628 |
| V          | 1250  |
| N          | 96800 |
| P          | 2520  |

#### 1st Order Interactions

| A x V      | 231   |
| A x N      | 1485  |
| A x P      | 136   |
| B x V      | 2520  |
| B x N      | 15312 |
| B x P      | 1624  |
| AB x V     | 1326  |
| AB x N     | 1017  |
| AB x P     | 2701  |
| V x N      | 392   |
| V x P      | 264   |
| N x P      | 1012  |

#### Partition of Error

| A x V x N   | 45    |
| AB x V x N  | 2       |
| B x V x P   | 450   |
| AB x V x P  | 1012  |
| A x N x P   | 3916  |
| B x N x P   | 3916  |
| V x N x P   | 50    |

**Total:** 13352
## Summary of Results

(Mean Yield in 100 lbs/acre)

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<th>2</th>
<th>σ</th>
<th>4</th>
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- S.O. Spacing means 93 49 19 37
- S.O. Varieties Fertilizer means 93 22 18 41

> p at 1% point

> p at 1% point
### SUMMARY OF RESULTS

(Mean Yield in 100 lbs/acre)

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<th>V/P</th>
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Means: 392, 383, 399, 316, 372

L.S.D. Spacing means 5% 40 1% 57

L.S.D. Varieties fertiliser means 5% 29 1% 41

S₁ S₂ S₃ > S₄ at 1% point
N₁ > N₀ at 1% point
APPENDIX 5a: YIELDS PER ACRE & PLANT NOS PER ACRE

**YIELD — 1000 LBS**

- GROSS WT \( V_1 \)
- GROSS WT \( V_2 \)
- MARKETABLE WT \( V_1 \)
- MARKETABLE WT \( V_2 \)

\( V_1 \)  CHARLESTON WAKEFIELD
\( V_2 \)  SUCCESSION

**PLANT NOS 1000's**
APPENDIX 5b: YIELDS PER PLANT & PLANT NOS PER ACRE

$V_1$ - CHARLESTON WAKEFIELD
$V_2$ - SUCCESSION

YIELDS 1 lb

MARKETABLE WT.

GROSS WT.

GROSS

PLANT NOS 1000's

0 5 10 15 20 25 30 35 40 45 50
### No. of dead plants caused by Rhizoctonia disease (weekly count)

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<th>Treatment</th>
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<th>Jan 21</th>
<th>Jan 28</th>
<th>Feb 4</th>
<th>Feb 11</th>
<th>Feb 18</th>
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Grand Total C/fwd 144
## Cabbage Production in U.S.A. (20)

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<th>Acres for harvest (1,000)</th>
<th>Yield per acre (1,000)</th>
<th>Production (1,000 cwt)</th>
<th>Price per cwt</th>
<th>Value ($1,000)</th>
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8-year av.

Total 7.76 inches.