Spiraled Heads in Lettuce

malformation in Great Lakes lettuce strains apparently an inherited character producing united wrapper leaf margins

Great Lakes lettuce, adapted to culture under a range of environmental conditions, normally produces a medium-large, globular, semi-exposed head. In some plantings, however, a percentage of the plant population develops conical-shaped heads, with the wrapper leaves or head leaves in a spiral-like fold. Market-stage plants of this type are generally referred to as spiraled heads. The shipper and retailer prefer a slightly oblate head with broad, flat butt, which can be packed evenly and firmly.

Observations made of 30 variety tests in the central coastal section of California from 1953 to 1957 indicated that some strains of Great Lakes produced more spiraled heads than did others. Premier Great Lakes, Great Lakes 428, and Great Lakes 118 were the least likely to produce spiraled heads. Lettuce planted for May, June or October maturity was more likely to have spiraled heads than lettuce reaching the harvest stage in the summer months. The results from four typical trials with both high and low percentages of spiraled heads are reported in the table above.

A close examination of plants with spiraled heads has shown that, in many cases, the margins of a wrapper leaf or leaves were united by a natural graft. Two types of united leaf margins were observed: two successively initiated leaves united along one side of the leaf lobe, and a union of opposite margins of a single leaf lobe, forming a tubular-like structure.

A survey was made over a three-year period to determine the relationship of united wrapper leaves to the formation of spiraled heads. This showed that spiral-head formation is associated with the occurrence of united wrapper leaves. This natural graft was found to range from the sixth to the sixteenth true leaf. These leaves—referred to as the wrapper leaves—fold loosely around or over the head. In none of the plants were united leaves found in the terminal bud, commonly called the head. It was also found that more spiraled heads were the result of a wrapper leaf united to itself rather than to a successive leaf.

In another study, observations were made on the head development of young plants with 12–15 true leaves. Fifty plants that had the margins of a single leaf united were selected and marked by placing a stake by the plant. The united leaf margins in 25 of these plants were carefully cut and the subsequent head development compared with that of plants with the united leaf margin intact and with plants that showed no united leaves. The results of three such trials are reported in the table on page 8 and concluded on page 8.

**The Percentage of the Plant Population with Spiraled Heads Occurring in 13 Strains of Great Lakes Lettuce in Four Trials**

<table>
<thead>
<tr>
<th>Great Lakes strains</th>
<th>Trial 1 June 28%</th>
<th>Trial 2 July 20%</th>
<th>Trial 3 Aug. 8%</th>
<th>Trial 4 Oct. 10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premier Gt. Lakes</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Great Lakes 118</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Great Lakes 65</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>26</td>
</tr>
<tr>
<td>Great Lakes 66</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>26</td>
</tr>
<tr>
<td>Great Lakes 623B</td>
<td>0</td>
<td>10</td>
<td>52</td>
<td>83</td>
</tr>
<tr>
<td>Great Lakes 366</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>48</td>
</tr>
<tr>
<td>Great Lakes 54</td>
<td>27</td>
<td>0</td>
<td>2</td>
<td>21</td>
</tr>
<tr>
<td>Great Lakes &quot;R&quot;</td>
<td>25</td>
<td>2</td>
<td>0</td>
<td>44</td>
</tr>
<tr>
<td>Great Lakes &quot;R&quot;</td>
<td>41</td>
<td>2</td>
<td>11</td>
<td>62</td>
</tr>
<tr>
<td>Great Lakes A-36</td>
<td>31</td>
<td>0</td>
<td>2</td>
<td>38</td>
</tr>
<tr>
<td>Great Lakes 407</td>
<td>20</td>
<td>0</td>
<td>3</td>
<td>56</td>
</tr>
<tr>
<td>Great Lakes 659</td>
<td>71</td>
<td>0</td>
<td>4</td>
<td>88</td>
</tr>
<tr>
<td>Great Lakes 428</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>18</td>
</tr>
</tbody>
</table>

* Date of first harvest.

Tubular-like leaf formed as a result of opposite margins united.
PACKING

Continued from page 2

and $0.041 for labor. The unit savings
with the bulk-filled carton over the stand-
ard crate are also $0.132 for container
material, but $0.160 for labor.

Since operating conditions—such as
plant size, proportion of culls, length of
operating season, and wage rates—vary
among plants, costs in particular plants
may differ from those shown. How the
costs given in the chart in the second
column on page 2, for example, are af-
fected by plant size is illustrated in the
graph in the first column on page 2. This
shows that with a given length of season,
unit costs drop as plant output capacity
goes up. In a 300-hour season—for
example—the total unit cost, in a plant
with a capacity rate of 100 crates per
hour, is $1.162 per crate; in a plant with
a capacity rate of 500 crates per hour,
total unit cost is $0.945 per crate; and, in
plants with 1,000 crates per hour capacity,
total unit cost is $0.918 per crate.

Unit costs also decrease as length of
season—with a given plant capacity—in-
creases. In a plant of 300 crates per
hour capacity, total unit cost with 100
hours operation is $1.344 per crate; with
300 hours operation, $0.951 per crate;
and with 500 hours operation per season,
$0.902 per crate. The reduction in unit
cost results from the spreading of fixed
costs—a function of plant capacity rate
—over a larger season volume.

The costs illustrated in the chart assume
that 20% of the fruit received will be
sorted out as culls. Similar estimates
based on only 10% culls indicate a
level of costs about 1.5% lower per stand-
ard crate than shown; and with 40% culls
these costs would be about 4.5% per
crate higher.

The variations in unit costs—for the
standard crate—as plant operating con-
ditions change also were studied for the
other two types of containers and filling
methods. While estimated costs with both
methods were lower than the standard
crate, the range in costs attributable to
plant capacity, length of operating sea-
son, and proportion of cull fruit would
be roughly the same.

Effects on Quality and Price

The effect of new containers and filling
methods on fruit quality and market
prices is not easily measured. Meaning-
ful comparisons of prices received with
different containers require evaluation
of many factors for which complete in-
formation was not available. These in-
clude information as to initial fruit
quality, variation in transit and market
conditions with respect to different test
shipments and the price-effect of trade
resistance to new containers available
only in light and irregular shipments.

An alternative to evaluation on the
basis of prices received on test shipments
is to observe the effect of type of con-
tainer on fruit quality. Test shipment
experience and laboratory transit tests
have suggested that place-packed or bulk-
filled containers can deliver plums of
quality equal to that obtained with the
standard crate. Therefore, it appears
that the industry could shift to the less
costly types of package without adverse
effect on market price. This would make
the net advantage with the new-type
containers equal to the reduction in
packing cost. On this basis, the industry
during the first year of the change would
save—on a 4,500-car annual shipment—
roughly $770,000 annually with the place-packed carton and $1,530,000 with
the bulk-filled carton. Over a longer
period of time—taking into account the
wear-out of the present packaging and
crate-making equipment and the costs of
its replacement—slightly larger annual
savings could be realized. The changes
in equipment are relatively minor, how-
ever, and the estimated annual savings
would be increased to approximately
$865,000 with the place-packed carton
to $1,440,000 with the bulk-filled carton.

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The place-packed test carton was developed
for test shipment by an industry committee
in cooperation with the California Grape and Tree
Fruit League.

This report is based on a more detailed study,
copies of which may be obtained without cost
from the Department of Agricultural Eco-
nomics, Room 207 Giannini Hall, University of
California, Berkeley 4.

LETTUCE

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substantiate the relationship of united
wrapper leaves to the development of
spiraled heads.

A special study of Great Lakes 6238
and Great Lakes 659 in comparison with
Premier Great Lakes showed that the
latter strain did not have any plants with
united leaves and spiraled heads.
The other two strains produced many
plants with united leaves and spiraled
heads.

A number of experiments were con-
ducted to test the hypothesis that a united
leaf or leaves bind the head and the re-
sulting mechanical pressure forces the
subsequent initiated leaves into a spiral-
like fold. In the first series of experi-
ments, plants in the early rosette stage—
15–30 true leaves—were selected and a
rubber band 2 1/2" long and 5/8" wide was
placed around each plant and left on
until the plants approached market
maturity. It was found that, if the rubber
band was kept around the upper half of
the wrapper leaves—which is the general

Effects of United Leaf Margin on the Subsequent
Development of Spiraled Heads.

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Treatment (Place-packed carton)</th>
<th>Number of spiraled heads formed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>United leaf margin intact</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>United leaf margin broken</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>United leaf margin intact</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>United leaf margin broken</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>United leaf margin intact</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>United leaf margin broken</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No united leaf margin</td>
<td>0</td>
</tr>
</tbody>
</table>

area where a united wrapper leaf or
leaves exert a similar pressure—the plant
would develop a spiraled head.

In a second series of experiments the
leaf margins of the sixth or sixth and
seventh leaves were stapled together to
exert on the developing head a me-
chanical pressure similar to that obtained
by natural union of wrapper leaves.
Plastic friction tape was also used to
help bind the leaf margins together. The
leaf margins were left stapled for 7, 14,
21, and 29 days.

The stapling together of the leaf mar-
gins of a single wrapper leaf, or the leaf
margin of one leaf to the successively
initiated leaf, caused spiral-head forma-
tion. A single wrapper leaf with its leaf
margins united was more effective in
causing spiral-head development than
when the leaf margin of a wrapper leaf
was united to a successively initiated
leaf. Pressure exerted on the developing
head for as short a period as seven days
was sufficient to cause spiraled heads,
and the longer the pressure was applied
the greater the chance for spiral-head
formation.

The differences observed between
strains of Great Lakes in producing a
united wrapper leaf or leaves under cer-
tain environmental conditions indicate
that this is an inherited character. It
appears that Great Lakes is segregating
for this character, and that selections
could be made within existing strains
for freedom from united wrapper leaves,
thus reducing the amount of spiral head
development.

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The above progress report is based on Re-
search Project No. 1175.