CAN PLANTS USE SODA IN PLACE OF POTASH?

F. H. HALL, W. H. JORDAN AND C. G. JENTER.
BOARD OF CONTROL.

GOVERNOR THEODORE ROOSEVELT, Albany.
STEPHEN H. HAMMOND, Geneva.
AUSTIN C. CHASE, Syracuse.
FRANK O. CHAMBERLAIN, Canandaigua.
FREDERICK C. SCHRAUB, Lowanda.
NICHOLAS HALLOCK, Queens.
LYMAN P. HAVILAND, Camden.
EDGAR G. DUSENBURY, Portville.
OSCAR H. HALE, North Stockholm.
MARTIN L. ALLEN, Fayette.

OFFICERS OF THE BOARD.

STEPHEN H. HAMMOND, President.
WILLIAM O’HANLON, Secretary and Treasurer

EXECUTIVE COMMITTEE.

STEPHEN H. HAMMOND,
MARTIN L. ALLEN,
FRANK O. CHAMBERLAIN,
FREDERICK C. SCHRAUB,
LYMAN P. HAVILAND,
NICHOLAS HALLOCK.

STATION STAFF.

WHITMAN H. JORDAN, Sc. D., Director.

GEORGE W. CHURCHILL,
Agriculturist and Superintendent of Labor.

WILLIAM P. WHEELER
First Assistant (Animal Industry).

FRED C. STEWART, M.S.,
Botanist.

LUCIUS L. VANSLYKE, PH.D.,
Chemist.

CHRISTIAN G. JENTER, PH.C.,
*WILLIAM H. ANDREWS, B.S.,
J. ARTHUR LECLERC, B.S.,
¶AMASA D. COOK, PH.C.,
FREDERICK D. FULLER, B.S.,
¶EDWIN B. HART, B.S.,
*CHARLES W. MUDGE, B.S.,
*ANDREW J. PATTE, B.S.,
Assistant Chemists.

HARRY A. HARDING, M.S.,
Dairy Bacteriologist.

LORE A. ROGERS, B.S.,
Assistant Bacteriologist.

GEORGE A. SMITH,
Dairy Expert.

FRANK H. HALL, B.S.,
Editor and Librarian.

VICTOR H. LOWE, M.S.,
†F. ATWOOD SIRRINE, M.S.,
Entomologists.

PERCIVAL J. PARROTT, A.M.,
Assistant Entomologist.

SPENCER A. BEACH, M.S.,
Horticulturist.

HEINRICH HASSELBRING, B.S.A.,
Assistant Horticulturist.

FRANK E. NEWTON,
JENNIE TERRILL, CLERKS AND STENOGRA.

ADIN H. HORTON,
COMPILER.

Address all correspondence, not to individual members of the staff, but to the NEW YORK AGRICULTURAL EXPERIMENT STATION, GENEVA, N. Y.
The Bulletins published by the Station will be sent free to any farmer applying for them.

* Connected with Fertilizer Control.
† At Second Judicial Department Branch Station, Jamaica, N. Y.
¶ Absent on leave.
Chemically considered, potassium and sodium are similar twin brothers. They are not of quite the same weight, but they look alike, they act alike, their dispositions are quite similar, they select the same companions and they form with other associates partnerships which resemble each other strikingly. Both are silver-gray metals—light-weights among the metals, as they are lighter than water; both are caustic alkalis, the active agents in our common lyes; both so urgently demand oxygen that they will draw this element from the air, from water or from almost any substance of which the gas is a part; and both unite with other chemicals to form compounds much alike in appearance and properties.

These metals can be kept in the uncombined state only in oxygen-free sealed tubes or under naphtha or some similar liquid which does not contain oxygen; for with access to oxygen they immediately unite with it and take the forms in which we know them best—potassium oxide, or potash, and sodium oxide, or soda.

Potassium is found in all plants and sodium in practically all, both usually in considerable quantities; though in some plants only traces of sodium have been found. Since these two substances bear a closer resemblance to each other than do any other

---

*This is a brief review of Bulletin No. 192 of this Station, on The Substitution of Soda for Potash in Plant Growth, by W. H. Jordan and C. G. Jenter. Any one interested in the detailed account of the investigations will be furnished, on application, with a copy of the complete bulletin. The names of those who so request will be placed on the Station mailing list to receive future bulletins, popular or complete as desired. Bulletins are issued at irregular intervals as investigations are completed, not monthly.
two elements commonly found in plants, the question early arose whether both are necessary to the life of the plant or whether one cannot act as a substitute for the other without affecting growth. Thirty years ago much attention was given to this problem and it was soon discovered that without potash no plant could come to maturity; for its presence is necessary before starch can be formed in the plant tissues. Soda was found to play no such important part and by most investigators it was regarded as rather accidental than otherwise. It is everywhere present in the soil, usually in forms readily accessible to the plant, and so, not being harmful, it is taken up in solution just as are many other elements which seems to have no definite function in plant economy. A few students of the question, however—not more than three or four of the twenty or more who gave it careful attention—thought it possible that sodium might to some extent replace potassium, but none went so far as to hold it a perfect substitute for the stronger alkali.

Now, potassium—or potash as we ordinarily speak of the substance in connection with plant growth—is quite expensive; but sodium, in salt and other forms, costs but little. If soda can replace potash when the latter seems to be required in soils to produce profitable crops, it is to our advantage to use the sodium compounds.

The great gain from such a substitution so impressed Mr. Andrew H. Ward that for years previous to his recent death he was an ardent advocate of the use of sodium salts as fertilizer, especially nitrate of soda which combines nitrogen and soda; and he vehemently urged that farmers only waste their money when they buy sulphate and muriate of potash. He seems to have given more weight to the bare possibility announced by the few investigators, that soda may be able to replace potash, than to the conclusions of the many that it can not do so. His writings were so widely circulated by the rural press and excited the interest and questions of so many farmers that it seemed best to this Station to go over the ground again, although there was no reason to distrust previous scientific conclusions.
It is only by tests in which all of the conditions can be controlled that we get positive information; so field tests with soda and potash were not attempted. The amount of potash and soda in the ordinary soil is so large as compared with the amount needed by even a maximum crop that the analytical methods of the chemist are frequently unable to note any difference in the quantities before and after the crop has been grown; therefore a soil in which to grow the plants was sought which should contain neither potash nor soda. Such a material was found in pure quartz sand made by grinding quartz rock. This contained only the merest trace of potash, less than $\frac{1}{1000}$ of 1 per cent., and none of the other fertilizer ingredients; yet the plants grew well in it when watered with solutions containing the ingredients needed. The test was carried out in a forcing house where heat, light and air could be well controlled and where uniformity for all the plants was secured to a satisfactory degree. Distilled water was used to supply the necessary moisture, and except for the fertilizers used, all the plants were treated alike.

Twelve pots were used for each kind of plant grown, in duplicate sets of six. The first pot received a complete fertilizer containing both soda and potash, in the second pot the soda was omitted, in the third the potash was left out, in the fourth neither potash nor soda was given, in the fifth nitrogen was the only fertilizing ingredient supplied, and in the last pot the plants were allowed to make such growth as they could upon the quartz sand and distilled water only.

In the test of the first year, when too late to change, peculiarities in the growth of the plants showed that all of the conditions sought were not obtained and careful study and analysis revealed the fact that some of the chemicals used were impure and contained minute quantities of potash. For this reason even the "without potash" pots contained a trace of potash and made a quite surprising growth. In the second season chemically pure materials were secured and the results obtained gave striking confirmation of the general belief that soda is not essential to plant life, and that it cannot take the place
of potash, which is essential. It is evident, however, that only a minute quantity of potash is absolutely necessary to growth; for in the first season barley plants in the "without potash" pots reached a weight, dry matter only, of 31 grams upon a potash content of only .4 of 1 per ct., while the plants receiving complete fertilizer produced only 69 grams of dry matter with a potash content of nearly 2 1/2 per ct.—nearly 6 times as much potash taken up with a growth only 2 1/2 times as great. With tomatoes the growth was 3 times as great with liberal potash supply as it was where only one-fifth as much potash was obtained by the plants; and the peas made four-fifths as much growth upon one-third of a gram of potash as they did upon 9 times as much.

Plate I shows the first four barley pots with the first season’s crop; and Plate II show all six pots in the second year’s test. The "without potash" pots show plainly the effect of the small amount of potash accidentally present the first year.

Study of these two plates, which are quite typical of the growth of all the plants tested, will show plainly that the soda played a very minor part in the growth of the crops. In the first series, it must be remembered, some potash was present in all the pots; but in both series the pots without soda gave as good or better yields than those with complete fertilizer, the pots without soda or potash practically as good as those from which the potash only was omitted. In case of all the species tested, when the plants had to depend for potash upon the very minute quantity contained in the quartz sand, they failed to develop vigorously. But when they had access to even the small quantity contained in the impure chemicals a marked improvement in vigor was the result. Where potash was lacking and soda present in abundance, it is true that the plants took up much larger quantities of soda than they did where potash was available; but this larger quantity of soda contained in the plants contributed nothing to their vigor and in no sense replaced potash as an active agent in plant growth.

These facts will perhaps appear more clearly in a summary of the plant yields and content of potash and soda expressed in figures. There were quite striking differences in growth and utili-
Plate I.—Barley in Potash-Soda Experiments, 1898–99:
Fig. 1, Early Growth; Fig. 2, At Harvest.
Plate II.—Barley in Potash-Soda Experiments, 1899-1900:
Fig. 1, Early Growth; Fig. 2, At Harvest.
zation of the fertilizers by the barley, tomatoes and peas grown; but they were differences of degree, not of character; so the data are combined here.

**Barley, Peas and Tomatoes Grown With and Without Potash and Soda.**

<table>
<thead>
<tr>
<th>Plant food supplied,</th>
<th>Yield of dry matter per pot.</th>
<th>Potash in dry matter.</th>
<th>Soda in dry matter.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Season—Impure Chemicals Furnished Accidental Potash Supply.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soda omitted</td>
<td>65.5</td>
<td>2.69</td>
<td>.64</td>
</tr>
<tr>
<td>Potash omitted</td>
<td>29.9</td>
<td>.47</td>
<td>3.55</td>
</tr>
<tr>
<td>Both potash and soda omitted</td>
<td>36.9</td>
<td>.51</td>
<td>1.61</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Second Season—Pure Chemicals Used.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete fertilizer</td>
</tr>
<tr>
<td>Soda omitted</td>
</tr>
<tr>
<td>Potash omitted</td>
</tr>
<tr>
<td>Both potash and soda omitted</td>
</tr>
</tbody>
</table>

It will be noticed from these averages that the omission of soda from the complete fertilizer increased rather than decreased the yield; while the omission of potash halved the dry matter the first year, when there was still available some potash, and quartered it the second year. This is true notwithstanding the fact that the plants without potash took up 3½ per ct. of soda the first year and 3 per ct. the second instead of the small quantities they used when potash was available. The yields of plant dry matter are no greater with these larger percentages of soda present than they are in the pots without any potash or soda (except very small accidental quantities), where the percentages of soda taken up are only half or, in the last season, one-sixth as great.

**Conclusion.** The deduction is inevitable, from this series of experiments as from the great majority of those previously recorded, that soda can not replace potash as an active agent in the development of plant life.
It seems evident, however, that the amount of potash necessary to produce good growth may in many cases be much less than that normally found in the plants. In other words, a little potash seems to go a long ways. Field experiments by the Station, also, have seemed to indicate that the quantity of potash necessary in fertilizers has been overestimated; but further careful testing will be necessary before the lower limit of essential potash can be placed.