

**UNIVERSITY OF ILLINOIS
AGRICULTURAL EXPERIMENT STATION.
BULLETIN NO. 127. A
STUDY OF THE FACTORS INFLUENCING
THE IMPROVEMENT OF THE POTATO, PP.
376-456**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649375219

University of Illinois Agricultural Experiment Station. Bulletin No. 127. A Study of the Factors Influencing the Improvement of the Potato, pp. 376-456 by Edward D. East

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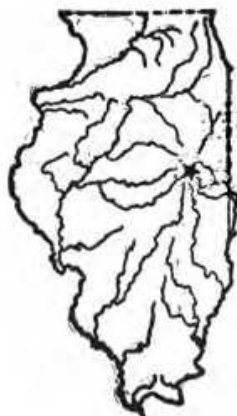
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UNIVERSITY OF
ILLINOIS

URBANA, ILLINOIS, AUGUST, 1908

TB 211
TSE 2

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A STUDY OF THE FACTORS INFLUENCING THE IMPROVEMENT OF THE POTATO*

By EDWARD M. EAST.

INTRODUCTION

Either because it possesses no strong flavor to dull the appetite, or possibly on account of its antiscorbutic properties, the common potato *Solanum tuberosum* L., has overcome seemingly insurmountable obstacles in its claim upon the public taste and has become a close rival to our cereal staff of life. The high cost of production and general uncertainty of the return, combined with the cost of transportation of a perishable, bulky product, would seem to be adverse factors which might preclude any general increase in growing the crop. Such has not been the case, however, and the potato, like other crops, has increased greatly in acreage in localities best suited to it, notably the sandy soils of the northern states. These soils seem to be so pre-eminently fitted for its growth that the crops are highly profitable even after deducting the cost of shipping long distances. During the last ten years,** the six states of Maine, New York, Pennsylvania, Michigan, Wisconsin and Iowa have furnished an average of one-half of the total crop of the United States. In other sections of the country where the growing of large crops is more unlikely from natural reasons, as inhospitable soil or climate, the cost of production has been high, and overproduction at times (as in 1895-6) has had a very disastrous effect upon the price, occasioning great loss to the producer. This state of affairs is in a great measure due to the fact that in these sections the acreage per grower is small, and the business is not sufficiently organized to make possible long distance shipping, which would partially overcome the great local fluctuation in price.

The annual consumption of potatoes per capita in the United States for a period of thirty years is given by the Twelfth Census as three and one-half bushels, and when the amount available for human consumption is smaller than this,—as has been the case in the last few years,—the price precludes their use for other purposes.

*Submitted to the Faculty of the Graduate School of the University of Illinois in partial fulfillment of the requirements for the degree of Doctor of Philosophy, March, 1907.

**U. S. Dept. of Agri. Yearbook, 1905.

This has left capital invested in starch mills completely unproductive, as the limiting price within which the manufacturer can compete is forty cents per barrel of two and one-half bushels. There is no doubt but that the repeal of the tax upon alcohol for industrial purposes will furnish a channel for the utilization of all future excess of production over that used for human consumption, should the manufacturers of starch, glucose, dextrin and desiccated product,—who can pay a slightly higher price,—be unable to utilize it. At the present rate of increase of our population, however, the annual increase of production for human food alone must be from 3,000,000 to 5,000,000 bushels; and an increase, which would be a factor in the production of alcohol at all comparable with that of Germany, would have to be many times that amount.

The broad problems which confront the grower who has to face these demands, are, increased yields per acre and the development of varieties adapted to specific purposes. In the first instance suitable soil, available plant food, and proper methods of tillage and of combating disease will do much; but here as well as in the second case, probably the possibility for as great an advance lies in the province of the plant breeder.

The matter of variety efficiency to produce tubers in large quantities may be regarded as a desired accompaniment to all strains, no matter what other particular characters they may possess. The special characters, with the possession of which new varieties should be originated, are (1) an increase in nutritive value, (2) an improvement in table quality, and (3) a higher starch content. Coupled with the possession of each of these qualities should be the very important character of resistance to disease.

Since the potato is one of the world's cheapest food sources, if there is a possibility of finally obtaining varieties, which, without being perfect foods, yet would furnish a more nearly proper ratio of protein and carbohydrates; it would be an inestimable boon to the world's poor, for protein is a much more expensive food constituent than starch. This problem is inseparably linked with improvement in general table quality, for quality must in some manner be correlated with composition. On the other hand, varieties should be originated which yield a large amount of starch per acre, for the use of those growing for the starch, glucose or alcohol manufacturer. It is recognized that at the present price of production, maize is a much cheaper source of alcohol than potatoes; but with the American taste for high starch potatoes, such potatoes would be used as food except in times of over production, until

cheaper methods of production and better varieties make the potato a competitor with the cereals for manufacturing purposes.

This study deals with such questions as have naturally arisen in trying to form a basis for practical work in potato improvement; and includes an examination of the literature bearing upon the possibilities of attaining this end. The principles underlying practical work in potato improvement are very broad,—much too broad to be adequately discussed in a single paper,—and yet it seems impossible to separate them into narrow lines without ignoring principles which are essential to the work. For this reason it has been thought best to consider briefly such of these as are indispensable, without regard as to whether in every case they have been touched in the experimental work. No attempt has been made to discuss historical, agricultural or economic data, however, except in so far as such subjects relate to the improvement of the potato in desirable hereditary qualities. A considerable amount of literature has made its appearance since the beginning of the experimental work in 1901; but we have endeavored to give a resumé of the present status of knowledge of the subjects.

The writer desires to express his obligation to the Directors of the Illinois and Connecticut Agricultural Experiment Stations, E. Davenport and E. H. Jenkins, through whom was made possible the use of laboratory and other facilities of these stations; and who have given much helpful advice. Especial acknowledgment is made to Dr. C. G. Hopkins under whose direction the study was undertaken, and who has been a constant source of advice and encouragement.

I. THE USE OF OTHER SPECIES

The plant which bears the tuber which we call the potato, and which name has been extended to the whole plant, has a recorded history of only three hundred years, it having been introduced into Europe about the end of the sixteenth century. Its botanical character caused it to be called *Solanum tuberosum* by Gaspard Bauhin (86) in his *Phytopinax*, printed at Bâle in 1596. This name was followed by Linnaeus when binomial nomenclature was introduced.

There are several other members of the genus which bear tubers, but none has yet become of commercial importance. About twenty tuber-bearing kinds of *Solanum* have been at different times classed as separate species. J. G. Baker (6) has given us probably our best classification, after having made a thorough examination of all species at Kew, the British Museum, and the Lindley Herbarium, as well as many growing specimens. He concludes that there are only six distinct species: *S. tuberosum* Linn., *S. Maglia* Schlecht., *S. Commersonii* Dun., *S. cardiophyllum* Lind., *S. Jamesii* Torr. and *S. oxycarpum* Schiede. Later, (7) he places *S. Maglia* as a variety of *S. tuberosum* which reduces the number of species to five.

Solanum Commersonii Dun. has been shown by Labergerie (65) to be in all probability the most promising of the other species, in its commercial possibilities. In his extended investigations, it showed a great tendency to produce bud variations in color which were permanent, and which when propagated showed great differences in the production of tubers, immunity to disease, etc. A violet variation showed absolute immunity to late blight *Phytophthora infestans* (Mont.) De By., for three years, while plants of *S. tuberosum* growing near were stricken. The yield was as high as 100,000 K. per hectare with a composition much the same as the common potato. Rev. J. R. Lawrence of North Middleboro, Massachusetts, has recently stated, however, that his plants have not been immune to late blight.

S. Maglia Schlecht. of Chili, *S. immite* Dun. of Peru, and *S. verrucosum* Schlecht. of Mexico, have all been mentioned as species and varieties especially worthy of being tried in the hopes of finding strains which by selection might become of commercial value and be immune to certain diseases, or with which the same end might be reached by hybridization with *S. tuberosum*. No valuable commercial strains from these sources, however, have yet been produced.

Stuart (92) found in 1904 that *S. Commersonii* and *S. poly-*

adenium were quite resistant to late blight, while *S. stoloniferum* was not. In his later (93) report of 1905, they all showed a high percentage of infection. None of these species or varieties gave marketable tubers in his tests, but they had hardly been cultivated by him long enough to have become adapted to Vermont conditions. De Candolle (22 p. 49) mentions that *S. verrucosum* is not disease resistant.

It seems unlikely from past results, that there will be any great progress made through straight selections of other species, if we except *S. Commersonii*. This species has been thus far very unsatisfactory in the United States, but there is in it still cause for experiment. It is very variable in its habits of growth, length of stolons, shape of tubers and other important characters; hence there may in time be some promising strains isolated. Until we have such strains established, there will probably be little good from hybridizing mediocre elementary species with the common potato, for the hybridization is effected with difficulty.

For two seasons the writer has had under observation some plants grown from tubers of Labergerie's stock imported by J. J. H. Gregory and son, Marblehead, Massachusetts. *Phytophthora infestans* has not been troublesome during either of these seasons; hence, no data have been obtained regarding the comparative resistance of the plants to the fungus. I am compelled to state, however, that in no character of leaf, stem, flower or tuber, is the plant different from common purple tubered varieties of *S. tuberosum*. Either there has been some mistake in Labergerie's seemingly careful work, and there has been a mixture with tubers of *S. tuberosum*; or we must conclude that there have been bud mutations in at least five or six characters of *S. Commersonii*, giving a plant indistinguishable from *S. tuberosum*. The truth of the latter conclusion would give us a unique phenomenon that is of extreme importance to science, and the case must be confirmed before it is accepted as a fact.

Our plants have flowered freely, but viable pollen has been produced in extremely small quantities. Numerous attempts at hybridizing with *S. tuberosum* have all failed.