

tilizers should prove more profitable on the better soils. With the rapid occupation of all available land, rise in land values, and the necessary introduction of more intensive methods of cultivation, the time is at hand if it has not already come, when the western agricultural states should be the greatest consumers of commercial fertilizers. That this important development should much longer be retarded if not blocked by popular adherence to an unscientific and antiquated theory is inconceivable, yet one finds not only some agricultural investigators, but even some fertilizer chemists still clinging to it.

The difficulty which seems to have the most significance for the rigid advocates of the older theory of fertilizer action is the supposed fact that only those fertilizers are effective which contain potassium, phosphorus (as phosphates), or nitrogen, and the question is seriously asked: why, if these ideas are correct, cannot sodium chloride be used in place of the more expensive potassium salts? The answer however is quite clear. It is no more reasonable to expect sodium chloride to produce the same effects that potassium chloride does than it is to expect these same effects from a soluble phosphate. Each salt has its own specific properties and must be expected to produce effects which differ in kind as well as degree; and this quite apart from the facts that there is some evidence favoring the view that sodium can partially at least replace potassium in the mechanics of plant metabolism,<sup>1</sup> and that it is recognized by every one that under the conditions of plant growth as we know them, the presence of potassium in the cell sap is essential to plant growth and the presence of sodium is not. As a matter of further fact, sodium chloride has sometimes been used as a fertilizer and in general with about the same kind of success that has followed the use of other soluble salts, namely, in a majority of cases there was a more or less satisfactory increase of crop production. Whether or not sodium chloride should have a place among the standard fertilizer salts is by no means a settled question, and time and further experience with it are needed. It has the essential requirements of a commercial fertilizer, in that it affects plant growth, under proper conditions favorably, it is obtainable from a large and permanent source of supply, and is cheap. Moreover, it is about the only substance meeting these requirements that is not generally in use as a fertilizer. If future experience should show that it is not a useful soil amendment it will certainly be for other reasons than that it does not contain a recognized plant food.

In this paper, it is pointed out that:

1. Crop production is the result of many factors, natural and artificial, and these factors are all mutually dependent.
2. No simple theory of fertilizer action can satisfactorily account for the known facts.
3. With intensive methods of cultivation, fertilizers are effective on all kinds of soils, and are the more efficient on the naturally better soils.

<sup>1</sup> See, for instance, the work of Wheeler and his colleagues, *Report of the State Experiment Station of Rhode Island*, 1894 to 1909.

4. Other materials than those containing the traditional plant foods may yet become valuable fertilizers, if they satisfy commercial requirements.

#### BLEACHING WITH SODIUM PERBORATE.

By J. MERRITT MATTHEWS, PH. D.

Though sodium perborate, as well as other salts of perboric acid, have been known to the chemist for some time, it has only been within the past year or two that their use has been put forward for purposes of bleaching. The chief salt which is available for this purpose is sodium perborate, though magnesium perborate has also been employed. Sodium perborate is a substance similar to sodium peroxide in that it has a considerable amount of loosely combined oxygen, which under proper circumstances is readily liberated from combination in the nascent state, and thus becomes available for use in bleaching.

Sodium perborate has been principally exploited in Germany during the past few years, where its use for various purposes of bleaching has been the subject of quite a number of patents, though it is to be doubted whether these patents possess any commercial value. From Germany the use of sodium perborate spread to England, where it has been the subject principally of advertisements rather than entering into any practical use. During the past year, sodium perborate has appeared in the American market, and we believe it is also manufactured in this country at the present time.

Sodium perborate is prepared from sodium peroxide and boric acid. As compounds derived from boron are all more or less expensive commercially as compared with compounds of sodium alone, it is reasonable to expect that sodium perborate would be more expensive than sodium peroxide when based on an equivalence of available oxygen. Furthermore, sodium perborate even in the pure condition, contains only 10.4 per cent. of active oxygen, whereas sodium peroxide contains about 20 per cent., or practically twice as much in the same amount of chemical.

In its general application to purposes of bleaching textiles, sodium perborate is very similar to sodium peroxide or hydrogen peroxide. In fact, the various per-oxygen chemical compounds which have from time to time been suggested as capable bleaching agents, such as perborates, percarbonates, and persulphates, all depend in the final resort for their bleaching activity on the fact that they readily furnish a solution of hydrogen peroxide when dissolved in water, or when their solutions are treated with a suitable acid. Therefore the bleaching process with all these reagents comes down to a question of bleaching with hydrogen peroxide. In the consideration of this question, the chief factors to be discussed are the comparative amounts of hydrogen peroxide formed from equal quantities of the different compounds, the relative cost of the hydrogen peroxide thus produced, and whether the decomposition of the product brings into the solution other ingredients which may hinder the activity of the hydrogen peroxide in its bleaching efficiency.

Hydrogen peroxide, itself, as it appears on the market is simply a solution of this reagent in water with usually a small amount of acetanilide, phosphoric acid, or other suitable preservative. The solution is quite dilute, usually containing about three per cent. of hydrogen peroxide, as stronger solutions are very unstable and cannot be kept for any length of time. The amount of preservative is very minute, its only purpose is to retard the decomposition of the hydrogen peroxide, and in its character and amount is without significance as far as its influence on bleaching is concerned. Sodium peroxide is a solid substance, and when dissolved in water gives rise to a solution of hydrogen peroxide and caustic soda. The latter has to be neutralized with sulphuric acid in the preparation of the bleaching bath; so this bath then consists of a dilute solution of hydrogen peroxide containing a relatively large amount of dissolved sodium sulphate or Glauber's salt. This latter substance is of a neutral character as far as the bleaching effect goes, but its presence in the bath in such large amounts as compared with the amount of actual hydrogen peroxide seems to lower the efficiency of the bleaching action of the latter. Sodium peroxide, however, on account of the high percentage of per-oxygen in its chemical composition, is a comparatively cheap source for the preparation of solutions of hydrogen peroxide, and is also much more stable. Owing to these facts, sodium peroxide has been largely employed in bleaching for the preparation of solutions of hydrogen peroxide.

Sodium perborate is even more stable in its nature than sodium peroxide, and it was principally on this account that it attracted attention for purposes of bleaching. Whereas sodium peroxide decomposes with violent rapidity when dissolved in cold water, sodium perborate requires to be dissolved in hot water in order that it be decomposed completely, and the resulting products are hydrogen peroxide, caustic soda, and borax. It may be probable, however, that some or all of the borax may exist in the solution as metaborate of sodium. The treatment of this solution with sulphuric acid for the purpose of neutralizing the caustic soda is not absolutely essential in the case of bleaching cotton materials, and the bleaching bath may be employed at an elevated temperature. In cases where the wool fiber is to be bleached, however, it would be very essential to neutralize the caustic soda with sulphuric acid, in order to avoid the destructive action of the caustic alkali on the wool. The same would also be the case in the bleaching of silk materials.

It has not been demonstrated that bleaching baths prepared from sodium perborate are as efficient as the bath containing pure hydrogen peroxide alone, and at the present market prices, solutions prepared from sodium perborate show a relatively higher cost for the same amount of active bleaching agent. In this respect, in fact, sodium perborate is expensive out of all proportion when compared with sodium peroxide. The exact utility of sodium perborate,

then, for purposes of general textile bleaching is hard to discover. Its only advantage that is at all apparent in this connection is that the bleaching solution may be employed at relatively high temperatures, and thus can be used directly in a kier; but whether it is an advantage to bleach at a high temperature or not is a question. It would usually be considered that bleaching carried out at as low a temperature as possible would be more conducive to the preservative of the good qualities of the articles being treated.

Under the present conditions it would seem that the only feasible application in view for sodium perborate would be in the laundries, where it could be efficiently employed in place of the chlorine bleaching agents at present used, and which are so exceedingly destructive of our collars and shirts as well as all our household cotton goods which perforce are required to make the trip to the laundry a few times. The modern laundry employs, in a reckless manner, bleaching agents for the purpose of whitening up the goods instead of hanging them out on the line and thus exposing them to the mild and effective bleaching action of the sun and atmosphere. The laundries are coming to be large users of either solutions of chloride of lime or electrolytically prepared solutions of sodium hypochlorite for bleaching purposes. Both of these solutions have practically the same effect in the rapid deterioration of cotton materials, especially when used by the more or less haphazard methods of the average laundry, and by persons who do not fully realize the destructive effect of chlorine and acid compounds on cotton. Many laundries fondly imagine that when they are employing an electrolytic cell for the preparation of their bleach liquor from salt water, they are only using the salt water itself for the whitening of the goods, and attribute the bleaching effect to some occult cause in the electric current. In reality, the electric current has nothing at all to do with the bleaching effect; the current is simply used for the purpose of decomposing the salt solution in order to form a solution of sodium hypochlorite, and this latter substance is as violent in its chemical action as a corresponding solution of chloride of lime. Again, it is highly probable that many laundries will attempt to apply their bleaching liquors in hot solutions, which, of course, is ruinous to the cotton material so unfortunate as to meet with this treatment. Again, if the laundry attempts to whiten materials containing wool or silk fiber in this manner with chlorine compounds, the animal fiber will naturally be destroyed. Merino underwear or half-silk underwear is often rendered unfit for further use by such treatment at the laundry.

Now if sodium perborate should be adopted by the laundry in place of chlorine bleaching compounds, it could be employed in hot solutions without danger of rapid destruction of cotton materials, and even its use would be a distinct advancement over that of either chloride of lime solutions or electrolytic bleach liquors where these are employed with skill

and judgment. When the effect on woolen and silk goods is to be considered, it must be borne in mind that the solutions prepared from sodium perborate contain a large amount of caustic soda, and unless this is properly neutralized by the addition of sulphuric acid, it will be very destructive to the animal fibers. It is, therefore, a question as to whether the laundry would be any safer on this line of goods by the use of sodium perborate. However, when considered in its general effect, we can see a distinct advantage in the use of sodium perborate for laundries over the present methods. But would not hydrogen peroxide itself be a far better agent for the laundry? for it would figure out cheaper than sodium perborate, and it could be used without fear on both cotton and animal fibers alike, just as it comes into trade without needing any skilled manipulation by the user, as is the case with sodium peroxide and perborate. The only advantage we can see for the sodium perborate is the fact that it can be employed in various scouring mixtures, such as soap, alkali, etc., to be used by the laundry in hot solutions; and whether this is an advantage to an intelligent laundryman or not is a question.

It is in this latter field, however, that sodium perborate is acquiring some trade. In Germany there are quite a number of proprietary mixtures on the market for the use of the laundry, which combine both a scouring and a bleaching effect. We meet with such compounds, for instance, as "Persil," which is a mixture of soap, soda ash, silicate of soda, and a small amount of sodium perborate. "Clarax" is another such compound, consisting of a mixture of borax, sodium phosphate, and sodium perborate. "Ozonit" is another proprietary mixture very similar to "Persil" and consisting of about the same ingredients in a somewhat different proportion. In England there are to be met a number of compounds known under the general title of "Perborin" products. Perborin, itself, is pure sodium perborate; Perborin M is a mixture of the perborate with soap and alkali especially designed to meet the requirements of the laundry trade for a combined scouring and bleaching compound.

During the past year, perborate compounds have appeared on the American market, but as yet the general trade is but little acquainted with them. It is probable, however, that if they are properly presented to the laundry trade as a substitute for the present chlorine bleaching compounds, they would meet with a rather ready acceptance.

## BOOK REVIEWS.

**Sewage Disposal.** BY LEONARD P. KINNICUTT, C. E.-A. WINSLOW and R. WINTHROP PRATT. John Wiley & Sons. 409 pages, 113 figures indexed.

This excellent book is a general survey on the sewage disposal problem from the various viewpoints of the chemist, the sanitary biologist and the engineer, with particular reference to the conditions

of American practice. The fundamental principles of chemistry and bacteriology are discussed, as well as their application to engineering practice. The authors have been assisted in preparation by many engineers, as is noted in the preface. The work is divided into thirteen chapters, as follows:

Chapter 1. Composition of Sewage.

Chapter 2. Disposal of Sewage by Dilution.

Chapter 3. Screening and Straining of Sewage.

Chapter 4. Preliminary Treatment of Sewage by Sedimentation.

Chapter 5. Preliminary Treatment of Sewage by Chemical Precipitation.

Chapter 6. Preliminary Treatment of Sewage by the Septic Process.

Chapter 7. Disposal of Sewage Sludge.

Chapter 8. Purification of Sewage by Broad Irrigation and Sewage Farming.

Chapter 9. Purification of Sewage by Intermittent Filtration through Sand.

Chapter 10. Purification of Sewage by Contact Beds.

Chapter 11. Purification of Sewage on Trickling and Percolating Beds.

Chapter 12. Disinfection of Sewage and Sewage Effluents.

Chapter 13. Analysis of Sewage and Sewage Effluents.

The reviewer knows of no so complete work in the English language. The subjects in the different chapters are treated scientifically, and intimate personal connection with the facts is evidenced throughout the whole work. Nearly every part of the sewage disposal field has been covered by this book and in a manner which will be most satisfactory to sanitary engineers and advanced students of the art. The omissions are few and comparatively unimportant, for example under self-purification of streams it would have been well to include the work of Spitta and others on the effect of algae as an agent of purification; also the important part which insects and the higher animals play in the removal of organic matter contributed to streams by sewage and sewage effluent, might have been mentioned. The illustrations in the book are especially valuable and there is some statistical matter which has appeared in book form for the first time. Even so recent an invention as the Imhoff or Emscher tank has been commented upon. This fact is an evidence of the thoroughly up-to-date character of the subject matter of this most valuable treatise.

R. S. WESTON.

**Le Celluloid.—Fabrication, Applications, Substitutes.** BY MASELON, ROBERTS and CILLARD. 520 pages, illustrated. Paris: A. D. Cillard. 1910. 20 francs.

The book is divided into three parts. The first part is devoted to the preparation of celluloid from the raw materials. In it are described various processes of nitration; converting of the nitrocellulose; plans, organization and cost of plant; laboratory control; dangers in manufacturing and precautions to be taken.