A METHOD FOR THE RENEWAL OF PLANT NUTRIENTS IN SAND CULTURES.

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The recent publications of Tottingham* and of Shive† have suggested the desirability and importance of having some method by which the effect of different nutrient solutions upon plant growth might be studied in the presence of some solid substance similar to the soil, but at the same time furnishing fewer chemical and biological complications. Acting upon this suggestion the writer has devised a method by which seedling may be grown in sand and the nutrient solution renewed or modified almost as readily as in water cultures. In duplicating in sand some of Shive's work with wheat seedlings in solution cultures, use was made of graniteware pots approximately 12 x 12 centimeters inside, tapering slightly at the base and having a wide projecting rim at the top and a capacity of 1500 grams of dry quartz sand when filled to within about three centimeters of the top. To provide for the removal of the solution a small lead tube was soldered into the side as near the bottom as possible. The soldered joint and the lead tube was covered with paraffin to guard against lead poisoning and the outlet closed by means of a short length of rubber tubing provided with a pinch cock. The description of the method given in the following paragraphs includes the details of manipulations from the starting of the seedlings to the harvesting of the plants. The seed is soaked in water and the seedlings grown in the manner described by Tottingham‡, to a height of about three or four centimeters, when they are ready to be transferred to the sand cultures. While the seed is being germinated 1500 grams of dry quartz sand (previously washed several times with distilled water) is weighed into the pot, the outlet at the bottom of the pot being screened on the inside by means of a plug of glass wool inserted before the pot is filled. With the pinch cock closed distilled water is now added to the pot until the sand is completely saturated, after which the pinch cock is opened and the surplus water is allowed to drain out through the tube at

*A Quantative Chemical and Physiological Study of Nutrient Solutions for Plant Cultures. Physiological Researches Vol. I, No. 4, May, 1914.

†A Three-Salt Nutrient Solution for Plants. Amer. Journal of Botany, 4:157-160, April 1915.

‡Tottingham. p. 176.

the bottom of the pot until the last free water has disappeared from the surface of the sand. A hemispherical clay funnel is placed in position as shown in the photograph and the pot is ready to receive the seedlings. After careful selection for uniformity, the seedlings, six in number, are planted equal distances apart on a circle drawn midway between the edge of the funnel and the wall of the pot. Care is taken to have the

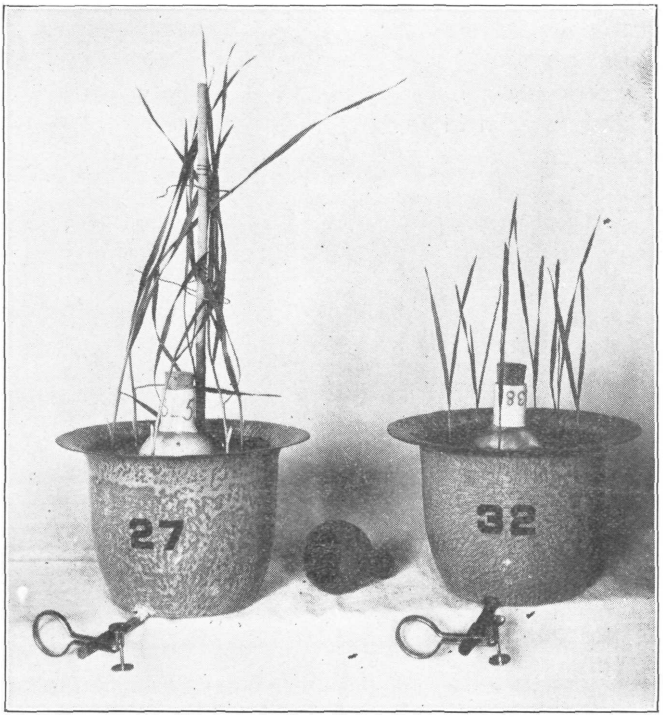

Fig. 1. Granite-ware pots for the study of plant nutrients in sand cultures.

seedlings at such depth that the top of the grain is just level with the surface of the sand. After all of the seedlings are in place the pinch cock is closed and the pot is tapped gently on the top of the table until free water appears on the surface of the sand. This manipulation serves to pack the sand around the roots of the seedlings and at the same time to level off the surface of the sand preparatory to putting on the seal of Briggs and Shantz* wax.

*Bul. No. 230, Bureau of Plant Industry, U. S. D. A., p. 13.

The surplus water is then drawn out of the pot by application of suction (by means of an aspirator) to the tube at the bottom and a thin layer of the melted wax is flowed over the surface, completely covering the surface of the sand between the funnel and the wall of the pot. Care should be taken not to have the wax too hot otherwise the seedlings may be injured at the point of contact between the wax and the plant. The surface must be sealed to prevent loss of water by evaporation from the surface of the sand and of course the walls of the pot must be impervious to moisture in order that transpiration can be measured and the concentration of the nutrient solution controlled. The pot is now ready to receive the nutrient solution, which is added through the funnel at the top while the water is being removed at the bottom by the application of suction to the outlet tube. A double or triple portion of the nutrient solution is passed through the sand at this first application in order to flush out the distilled water. The pot is now placed on the scales and the removal of solution is continued until the sand has been reduced to the desired moisture content which should be as near the optimum as possible. At the end of each three-day period the pot is weighed and sufficient water is added through the funnel to bring the system back to its original weight. A fresh nutrient solution is now added in the desired amount (250 cc. for pots of this size), while an equivalent amount of solution is removed at the bottom. A nutrient solution of the same concentration may be used throughout the entire growth period or it may be varied from time to time as the plants continue to develop.

The plants may be harvested at any time by removing the wax seal and cutting off the plants level with the surface of sand and, if desired, the roots may be recovered from the sand by washing them out with a jet of water. The weight records will give the transpiration of each culture and the harvest records can be made to include the dry weights of both tops and roots. This method also furnished a means by which the original concentration of the solution can be compared with its concentration after contact with the soil and with the plant roots. The method is superior in many ways to water cultures because it permits the plants to be grown under conditions that approximate those found in the field, so far as the sub stratum is concerned, and it seems probable that with some slight modifications which are now in progress it will be possible to apply the method to cultures grown in sandy and sandy loam soils.

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