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EXPERIMENTS WITH EPHEDRA IN THE SOUTHWEST.*

BY A. F. SIEVERS.

There is wide interest in the effects of the war in the Far East on the present and future status of the drug mahuang obtained from several species of Ephedra, the domestic requirements of which have come mainly from China. Manufacturers of ephedrine and of preparations containing this alkaloid are naturally concerned about the future source of the crude drug. Other parts of the world, particularly India, are being drawn upon and perhaps more extensive use of a synthetic product already on the market may result. While these adjustments are going on, the possibility is naturally being suggested that Ephedra be grown in this country in order that we may be independent of foreign supplies, not only during the present emergency but indefinitely. The general public has become interested through frequent mention of the matter in newspapers and trade journals. This is evidenced by the many inquiries received in the Department of Agriculture from people in many walks of life who want to know how to grow this drug plant, how much profit there is in it, how the active product is extracted, how it is marketed, where to obtain seed or plants, etc. Many of those interested live in regions where the Ephedra species would not grow or thrive and others are entirely lacking in the necessary experience in special plant culture. It is the duty of a Government agency to inform them frankly of the true situation and the reasons therefor.

It is not intended in this paper to discourage interest in, and consideration of, the possibilities of domestic growing of Ephedra. However, as in the case of other special crops, some of the news items that have appeared in the public press are misleading. They point out that here is an opportunity for farmers and others to grow a valuable crop but fail to mention the difficulties likely to be encountered. The purpose at this time is to emphasize the desirability of research to determine fundamental facts concerning the culture of such plants, if information is lacking, before their commercial growing is undertaken. At least this will prevent some of the mistakes that will otherwise probably be made. Medicinal plant culture differs in at least one important respect from the growing of most of the staple crops with

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which people are familiar. The value of medicinal plants depends entirely on certain constituents present in most cases in very small amounts. What factors concerned in the culture of the plants affect these constituents and how much, are matters that should first be determined. Seed and planting stock must be of known origin, and the effects of soil, climate and management practices on growth and quality must be known in order that the most suitable region for the purpose may be selected. It is obvious, that such fact-finding is properly the function of Government and State experiment stations and other scientific institutions, where specialists in the agronomic and chemical fields are available and where authentic material can be secured from a variety of sources. The investigations being conducted in South Dakota by the Division of Pharmacy of the South Dakota State College, at Brookings, as reported by Christensen and Hiner, have attracted particular attention because they seek to determine the possibilities of Ephedra on some of the marginal soils in the State.

The Bureau of Plant Industry of the Department of Agriculture became interested in the possibilities of providing a domestic source of natural ephedrine ten years ago at which time it was agreed that even if Ephedra culture proved to be possible in competition with foreign sources, it would be a relatively small enterprise with little opportunity for many people to engage in it. It seemed advisable, therefore, to undertake such studies without undue publicity since nothing could be gained by arousing general public interest until some facts had been obtained. Several divisions of the Bureau collaborated in the work. The Division of Plant Exploration and Introduction and the Division of Fruit and Vegetable Crops and Diseases secured seed of various species from different parts of the world and cultivated the plants at their field stations in regions then deemed best adapted to the purpose. The Division of Drug and Related Plants undertook the analysis of the material grown. The early results on the latter phase of the work is credited to the late O. F. Black who examined many samples by the Biuret test for preliminary indications of alkaloid content and who, with his assistant, J. W. Kelly, published several short papers on the subject. This test was modified to adapt it for rapidly evaluating very small samples as a means of finding individual plants of exceptional merit among the several species grown. These early results were the basis of the gradual development of select planting stock which has been under observation to the present time.

It seemed logical at the beginning to assume that the Ephedras would, on the whole, be best adapted to the arid regions of the Southwest, and it was in this region that most of the introductions were kept under observation. Chico, Torrey Pines (near La Jolla), and Banning, California and several locations in Arizona were the principal points of observation during the first years. Most of the material examined in the laboratory came from Torrey Pines where Black spent six weeks in the summer of 1931 testing many plants by the rapid method previously mentioned.

The species that have thus far been introduced and studied include: *E. sinica*, *E. gerardiana*, *E. likiangensis*, *E. helvetica*, *E. distachya*, *E. intermedia*, *E. altissima*, *E. alata* and *E. alenda*. Determination of the species has in some cases been difficult, especially when no flower or fruit was available and some doubt still exists concerning some of the introductions under the last two names. Some of these, though of no immediate interest from the standpoint of their ephedrine content, may be of

value for breeding purposes if they possess good growth habits, productiveness and adaptability to new environments.

In 1933 coöperative relations between the Bureau of Plant Industry and the Research Corporation of New York were effected and coöperative studies were in progress at La Jolla, California, from that time until December 1937, when this coöperative work was discontinued.

Recent years have been devoted largely to increasing the plantings of several of the more important species, particularly *E. sinica* and *E. gerardiana*, to secure information on yield of herb and related points that enter into consideration of the economic aspects of the crop. At the same time many individual plants were tested by the Biuret test, ephedrine determinations made whenever necessary, and much pertinent information developed regarding the several species.

In the early summer of 1937 the writer visited the plantings and after a careful survey arranged for a definite program calling for the systematic collection of material for assay and for a number of definite field experiments with certain specific objectives. The systematic collection of samples for analysis under this program was begun in August 1937 and continued monthly for one year.

The Soil Conservation Service of the Department became interested in the possible usefulness of Ephedra species in erosion control several years ago and at that time a considerable planting of various species in coöperation with the Bureau of Plant Industry was made at its nursery at Tucson, Arizona. The Bureau of Plant Industry provided the stock from material on hand at its several field stations, under a definite plan of concentrating all Ephedra plantings at that point, since Ephedra seemed to grow well under the conditions in that area. Late in December 1937, most of the plants from the several lots were moved from Torrey Pines to Tucson. These included selections and hybrids of special interest on which analytical data had been otbained, as well as many small seedlings not yet examined. Some time will be required for these plants to adjust themselves to the new location after which their examination will be continued. In the meantime, the already large plot of plantings at the Tucson nursery is being utilized in a definite program which involves studies on the following: (1) Changes in ephedrine content of eight species; (2) effect of irrigation and other management practices on ephedrine content and growth rate of four species; (3) rate of growth after cutting various distances from the ground; (4) yield of herb of the several species; (5) relative production of ephedrine per acre as determined by the percentage of alkaloid present and the quantity of herb produced by several of the most promising species, hybrids and selections; (6) observations on adaptation; and (7) studies on propagation methods and related problems.

It is not the intention of this paper to present all the data that have been procured to date. A paper on the most important results obtained at La Jolla will be published later. However, several hundred ephedrine determinations have been made and it may be well at this time to give the maximum and minimum ephedrine content in several series or groups because they are significant indicators of the wide range in the quality of individual plants of a species and of hybrids. Two selections of *E. gerardiana* made originally on their showing by the Biuret test were found to contain well over one per cent of the alkaloid. Two seedlings of *E. sinica* were likewise selected and progeny from these grown from suckers. In the case of

one of these, the minimum and maximum ephedrine content of monthly composite samples during the period August to December was 0.96 and 1.30 per cent, respectively, while in the other it was 0.99 and 1.31 per cent. Composite samples from the large plots of the species from which these originally were selected contained only 0.571 and 0.672 per cent, respectively, during the same period.

Two hybrids are of special interest. The seedlings grown from these have in both cases shown a wide variation in ephedrine content, the minimum and maximum being 0.24 and 1.28 per cent in the seedlings of the one and 0.07 and 1.25 per cent in those of the other. One species from Morocco, not yet definitely named though presumed to be *E. alenda*, is unique in that it contains pseudo-ephedrine almost exclusively, only very small amounts of ephedrine having at times been found in it. This is a fast growing species that would probably produce much more tonnage of herb than any of the others and may be useful for crossing with others less vigorous but with a high ephedrine content.

The few results mentioned are examples of the kind of information that may reasonably be expected from an investigation of this sort. Data on ephedrine content under various conditions are most important, but probably no more so than information concerning the cultural requirements, yields, cost of production, etc., of these plants, all of which are factors that in the end will determine whether or not Ephedra will be grown in this country.

AN EXPERIMENTAL STUDY OF FACTORS INVOLVED IN THE USE OF SURFACE ANTISEPTICS.*

BY LEO T. SAMUELS.[1]

INTRODUCTION.

The evaluation of an antiseptic designed for surface application involves many factors which have been only imperfectly correlated.

The phenol coefficient alone has long been recognized as an imperfect gage to the value of such a preparation. The presence of body fluids greatly affects bactericidal potency. A correction for this has been introduced by adding such substances as blood serum to the dilution medium in the phenol coefficient test. In recent years the importance of the toxicity of the material to body cells in comparison with its toxicity to bacteria has been recognized. But the relative values of common antiseptics obtained by methods designed to measure such a relation do not, in many instances, coincide with clinical experience.

Irritant action is an important variable among the common surface antiseptics. This factor does not bear a simple relation to the toxicity toward body tissues; many substances are highly toxic which are not among the most irritant. It has been thought that the inflammatory process generated by a substance such as iodine may be a valuable factor in promoting healing and in certain chronic lesions this seems to be true. Since healing is desired in many uses of surface antiseptics the rôles of inflammatory reactions and other factors in this process need study.

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