FIG. 2. Dr. KASANOFF and the mineral nutrient experiments at the Agricultural College at Detsko Selo. Photograph by HARVEY.

The work of the Institute of Applied Botany under the active leadership of Dr. VAVILOV has concerned itself greatly with the physiological problems related to plant geography and plant introduction.

One gets the impression of a thoroughly conscientious and helpful governmental support for fundamental research throughout Russia. The lack of organization of the work in plant physiology and geography in our own Bureau of Plant Industry is certainly in strong contrast with the fine conditions given by the Bolsheviki for these phases of research. Very few of the scientists in Russia are Communists, yet their work is given excellent support. The scientist is left alone by the politicians. If our government is ever to give adequate support to the fundamental and necessary work in plant physiology, the research organizations supported by the government must likewise be entirely free from political and unsympathetic management.—R. B. HARVEY, *Cambridge University, England.*

SOIL MOISTURE AT PERMANENT WILTING OF PLANTS

The residual moisture in the soil when plants attain the condition known as permanent wilting has been the subject of much work and discussion among those interested in plants and soils. BRIGGS and SHANTZ held that when a given soil reached a certain moisture content, plants growing thereon wilted, and could not be revived until additional water

was added to the soil. CALDWELL, and SHIVE and LIVINGSTON, disagreeing with this conception, held that permanent wilting depended upon atmospheric evaporating conditions. BRIGGS and SHANTZ further held that the wilting coefficient of a given soil could be calculated from the moisture equivalent without the necessity of a direct determination by actually wilting the plants. As a result of some 1300 trials with 20 soils they reached the conclusion that the wilting coefficient could be obtained by dividing the moisture equivalent by the factor 1.84.

In extensive experiments extending over a period of years, the writers have observed a remarkable constancy of the residual moisture content for a given soil when permanent wilting is attained under widely varying evaporating conditions. While most of the work was done with sunflowers, a number of trials with other plants seemed to substantiate the contention of BRIGGS and SHANTZ that on a given soil all plants reduce the moisture content of the soil to about the same extent when permanent wilting is attained. In an earlier report[1] the writers showed that with some soils there was a remarkable agreement between the observed and the calculated wilting coefficient. However, later results with many kinds of soils do not uphold the correctness of the 1.84 ratio, and we do not believe that a common factor for all soils may be used to calculate the amount of water which remains in the soil at permanent wilting.

The plants were grown in two sizes of containers under the varied seasonal atmospheric conditions which prevail at Davis, California. Maximum temperatures varied from about 45° F. during the winter months in an unheated greenhouse to 115° F. out-of-doors during the summer. Evaporation during these periods from a white spherical atmometer varied from 4 or 5 cc. to 80 cc. for 24 hours. A full description of the experiments will be published later. Some of the results obtained in over 2000 trials with 29 soils are given in the acompanying table.

It will be seen at once that the ratios range from 1.73 to 3.82. The results show clearly that there is no relation between the ratios obtained and the type of soil used. No logical grouping is possible because some of the highest as well as some of the lowest ratios were found within a given classification of soils. For example, high and low ratios were found with sands, with loams, and with clays. It would thus seem from the data obtained with the soils and plants used in these experiments that the residual moisture at permanent wilting cannot be obtained in every case from the moisture equivalent by use of the factor 1.84.

[1] VEIHMEYER, F. J., and HENDRICKSON, A. H. Soil Moisture conditions in relation to plant growth. Plant Physiol. 2: 72–81. 1927.

TABLE I

RESIDUAL MOISTURE AT PERMANENT WILTING AS DETERMINED WITH SUNFLOWER PLANTS OCTOBER, 1927, TO JUNE, 1928, AT DAVIS, CALIFORNIA

SOIL	NUMBER OF TRIALS	*MOISTURE EQUIVALENT	* PERCENTAGE OF MOISTURE IN SOIL AT PERMANENT WILTING	RATIO OF MOISTURE EQUIVALENT TO MOISTURE AT PERMANENT WILTING
N	18	3.29 ± 0.022	1.41 ± 0.031	2.33 ± 0.054
U	16	6.05 ± 0.036	3.50 ± 0.030	1.73 ± 0.018
HS–2	35	8.32 ± 0.033	3.67 ± 0.020	2.27 ± 0.015
HS–1	35	8.84 ± 0.041	3.99 ± 0.030	2.295 ± 0.020
FS	226	10.50 ± 0.026	3.08 ± 0.007	3.41 ± 0.011
TL	78	13.71 ± 0.021	4.51 ± 0.020	3.04 ± 0.014
J	17	17.07 ± 0.017	6.15 ± 0.070	2.775 ± 0.013
Y	40	17.16 ± 0.033	8.82 ± 0.027	1.95 ± 0.007
TC	24	17.30 ± 0.044	7.89 ± 0.040	2.19 ± 0.012
S	39	21.35 ± 0.043	10.20 ± 0.029	2.09 ± 0.007
OL	27	23.36 ± 0.052	6.12 ± 0.033	3.82 ± 0.022
OC	29	24.51 ± 0.050	11.55 ± 0.059	2.12 ± 0.012
MG	151	25.63 ± 0.039	10.47 ± 0.025	2.45 ± 0.007
V	24	37.90 ± 0.067	19.03 ± 0.074	1.99 ± 0.008

* Calculated on a dry weight basis.

While the residual moisture content of some soils at permanent wilting shows close agreement with the 1.84 ratio, as the writers have previously shown, the general use of this ratio for all soils is open to serious criticism. From the foregoing data, it is evident that the amount of water available for plant growth cannot be determined from the moisture equivalent alone. In the opinion of the writers, the moisture equivalent is the best single-value determination for interpreting the moisture properties of soils, but it is not an exact measure of how much of that water is available to growing plants. For accurate work it is evident that the amount of readily available moisture can be obtained only when the amount of residual moisture at permanent wilting is known, because it seems that plants are able to reduce the moisture content of different soils to different degrees of dryness before this stage of wilting is reached.—F. J. VEIHMEYER AND A. H. HENDRICKSON, *University of California.*