bra is the intellectual instrument which has been created for rendering clear the quantitative aspects of the world." But are these aspects important? "Through and through the world is infected with quantity. To talk sense is to talk in quantities. It is no use saying that the nation is large,—How large? It is no use saying that radium is scarce,—How scarce? You can not evade quantity. You may fly to poetry and to music, and quantity and number will face you in your rythms and your octaves."

What artist or man of letters has spoken deeper and truer words than the following words spoken by a logician and mathematician regarding style as an aim and test of education? "Finally there should grow the most austere of all mental qualities; I mean the sense for style. It is an esthetic sense based on admiration for the direct attainment of a foreseen end, simply and without waste. Style in art, style in literature, style in science, style in logic, style in practical execution have fundamentally the same esthetic qualities, namely, attainment and restraint. The love of a subject in itself and for itself, where it is not the sleepy pleasure of pacing a mental quarter-deck, is the love of style as manifested in that study. Here we are brought back to the position from which we started, the utility of education. Style, in its finest sense, is the last acquirement of the educated mind; it is also the most useful. It pervades the whole being. The administrator with a sense for style hates waste; the engineer with a sense for style economizes his material; the artisan with a sense for style prefers good work. Style is the ultimate morality of mind. But above style, and above knowledge, there is something, a vague shape like fate above the Greek gods. That something is Power. Style is the fashioning of power, the restraining of power. . . . It is the peculiar contribution of specialism to culture."

Never before have I been tempted in reviewing a book to quote so many of the author's words. I have felt that Whitehead must be allowed to speak for himself. The foregoing quotations are but samples of his manner in dealing with other great questions of science and education. It is my hope that the samples may induce readers of SCIENCE to read the book.

C. J. KEYSER

COLUMBIA UNIVERSITY

SPECIAL ARTICLES

A PRELIMINARY NOTE ON SOIL MOISTURE AND TEMPERATURE FACTORS IN THE WINTER-KILLING OF GRAIN CROPS

FEW investigations show the relation of kind of soil and moisture to temperature during the winter while none deal with their relation to the winter survival of crop plants. Winter-killing and spring condition of alfalfa, clover, winter wheat, oats, rye, barley, and other crops are very largely dependent on soil temperature during the winter months. These factors have been studied at the Kansas Experiment Station in connection with a general study of the causes of winter-killing of cereal crops.

In the fall of 1914 records were taken of the temperature in three plots of silt loam, to each of which different quantities of water were added during the fall and winter, and on which winter wheat, winter barley, and winter oats were grown. In the fall of 1915 three plots of heavy clay and two of sand were included, there being added to each plot different quantities of water as before. The temperature was recorded at a depth of one inch, three inches and six inches by means of standardized toluol thermometers during the first season, while electric thermometers were used the second. There was no heaving of the soil in either season and the survival of the plants appeared to depend on temperature alone.

The interrelation between the factors studied is very complex, the net resultant varying widely with the degree of variation of the single factors, and also with the character of the season, especially the degree of cold; the duration of freezing weather; the rate of change of air temperature; and the amount of snow. In the first season the lowest temperatures were recorded on the dry plot and the survival of the barley and oats was decidedly less than for the medium wet or the wet plots. The wheat survived practically

alike on all plots, there being very little injury to this cereal. Directly contrary results were obtained the second season, the temperature being lowest and the survival least on the wet plots.

This apparent anomaly seems to have been due to the character of the seasons and the changes in specific heat and thermal conductivity that takes place when water changes to ice. The first winter was comparatively mild and snow covered the plots during the coldest weather to a depth of several inches. As a result the soil was never frozen more than a few inches deep or for more than a few days at a time. Consequently, the changes in temperature were much less rapid on the wet than on the dry plot because of the specific heat and the latent heat of fusion of the water. The temperature of the wet plot was therefore more uniform, the highest daily maxima and minima being recorded for the dry plot.

The second winter was colder, and since the plots were not protected with snow they were frozen most of the time. The relationship between the wet and dry soil that was maintained during the first season was directly reversed, the lowest daily minima and the least survival being recorded on the wet soil. This reversal was apparently due to the difference in specific heat and the thermal conductivity of ice and water. When water freezes the specific heat is reduced approximately one half while the thermal conductivity is increased more than three times.[1] Consequently the difference in apparent specific heat of a wet and a dry soil is much less when it is frozen than when unfrozen, while the difference in thermal conductivity is greatly increased. The increase in the latter is sufficient to overbalance the difference in apparent specific heat permitting the temperature fluctations of the air to be more quickly recorded in the soil.

The wet and dry clay plots exhibited the same relation between moisture content, temperature and winter-killing that was found for the silt loam, only in greater degree. For example, 81.7 per cent. of the wheat and 11.7 per cent. of the barley survived on the dry silt loam as compared with 52.5 per cent. and 7.2 per cent. for the wheat and barley, respectively, on the wet silt loam, or a difference in favor of the dry soil of 29.5 per cent. for the wheat and 4.5 per cent. for the barley. On the clay, 89.4 per cent. of the wheat and 58.8 per cent. of the barley survived on the dry plot as compared with 20.4 per cent. and 2.1 per cent. for the wheat and barley, respectively, on the wet plot, or a difference of 69.0 per cent. for the wheat and 18.3 per cent. for the barley. The difference in temperature between wet and dry plots was also greater on the clay than on the silt loam.

On the sandy plots the effect of moisture on temperature and winter-killing was contrary to its effect on clay or silt loam when the soil was frozen, but corresponded qualitatively with the latter types when they were not frozen. The temperature of the dry sand was lower during the winter and the survival less than for the wet sand, freezing apparently having little influence. This was probably due to the fact that sand is a much better conductor of heat than other soils and hence there is less difference in the thermal conductivity of wet and dry sand than for soils of the heavier types. Also the water capacity of sand is much less than that of other soils, and there is consequently less change in the thermal conductivity when it is frozen.

Further data may permit prediction on the relative survival of grain crops on soils of different type and moisture content. The preliminary work indicates that a sandy soil is colder and the survival of plants growing upon it less than on a dry clay or loam soil, and also colder than a wet clay or a wet loam during those seasons when the ground remains unfrozen much of the time. It appears probable that dry sand is colder during the winter than a wet sand regardless of the character of the season, but a dry clay or silt loam is colder than a wet soil of the same kind, only when the ground remains unfrozen.

S. C. Salmon

Kansas State Agricultural College,
Manhattan, Kans.

[1] Reed and Guthe, Macmillan Co., 1914.