appeared. It gives an interesting account of the ethnology and culture of the peoples of these islands.

HENRY FAIRFIELD OSBORN

NOTES ON METEOROLOGY AND CLIMATOLOGY

THE EFFECT OF SNOW UPON THE GROWTH OF WINTER WHEAT

IT has long been believed that a snow cover is a beneficial factor in the growth of winter wheat; but some doubt has recently been cast upon this view, at least with respect to Ohio and Illinois, for which the question has been studied. Two short papers, one by Mr. Clarence J. Root[1] and the other by Professor J. Warren Smith,[2] have served as introductory to a longer discussion by Mr. T. A. Blair.[3] Professor Smith draws a clear distinction between the quantity of snowfall with its subsequent effect and the effect of a snow covering, for it may well be that a very heavy snow will melt quickly and leave the ground bare for a considerable time, or that a very light snow will remain for a long time unmelted on the ground. Thus, the question of the relation of snow and winter wheat is divided into two distinct aspects.

The first aspect has been discussed by Mr. Blair. His method of treating the problem is two-fold: first, by the well-known method of partial correlation, and second, by expressing the yield in linear regression equations of the form $Y = a + b_1x_1 + b_2x_2 + b_3x_3 + \ldots$, in which Y is the yield; x_1, x_2, x_3, . . . are the various weather elements, such as mean temperature, total precipitation, sunshine, etc.; and b_1, b_2, b_3, . . . are constants for a given equation depending upon the data. In expressing such relationships, the author has had to assume that there is a linear relation between the weather and yield, which, as he says, "is doubtful in cases of extreme weather conditions," and also that the most important weather influences have been included in his equations. Of the latter, perhaps the most important are temperature and precipitation, although there are many other factors which are not considered owing to lack of data, but which are more or less directly related to the weather, namely, hessian fly and other insects, severe storms, hail, and loss of crop by storm after it is cut.

Taking the state of Ohio as a whole, Mr. Blair finds that there is little evidence that there are monthly values of weather elements which exert a profound influence upon the yield of wheat. After obtaining this negative result, he proceeds to treat smaller areas of the state and shorter periods than the month. First, confining his area to Fulton county, and his period to 10 days, he finds that there are certain conditions of temperature and precipitation—the former more than the latter—operative over short periods, and these are the dominant factors in determining the final yield.

His conclusions, which seem to cast doubt upon the validity of the practise of the Bureau of Crop Estimates in publishing crop estimates as early as December 1, show that for the state as a whole, a warm March and June and a cool, dry May are favorable for a high yield. There are certain critical stages in the development of the plant, in which the conditions during certain 10-day periods may exert an important influence, especially in northern Ohio. It is found that the weather should be cool during the jointing stage, dry during the development of the boot, warm while the head is filling, and warm during the last ten days of stooling. As to the quantity of snowfall, it appears that a heavy fall of snow in March is detrimental. Forecasts of yield, earlier than May or June, believes Mr. Blair, can be of little value, because of the great influence of temperature during those months.

The second aspect of the distinction drawn by Professor Smith, was investigated by Mr.

[1] "The Relation of Snowfall to the Yield of Winter Wheat," *Mo. Weather Rev.*, October, 1919, Vol. 47: 700, 4 figs.

[2] "The Effect of Snow on Winter Wheat in Ohio," *ibid.*, pp. 701–702, fig.

[3] "A Statistical Study of Weather Factors Affecting the Yield of Winter Wheat in Ohio," *ibid.*, December, 1919, Vol. 47: 841–847, 2 figs.

Root in Illinois. He attempted to correlate the number of days with snow on the ground between December and March inclusive, or the number of days in March with freezing weather while the ground was bare, or even the number of days throughout the whole winter when the temperature was below 20° F. with the ground bare, with the yield of wheat in central Illinois, and in every case, he obtained a correlation coefficient so small as to cast great doubt upon the importance of the snow cover in determining the yield of wheat. More specifically, he found that there is reason to believe that wheat has a better prospect when the ground is not covered in January. The best years have been those with less than normal snowfall and with the temperature above normal for the winter. The years of poorest yield were those in which the winters had heavy snow and the temperatures were below normal. The companionship of warm winters and subnormal snowfall, and of cold winters and above-normal snowfall, is doubtless attributable to the fact that in a warm winter much of the precipitation falls as rain and that a snow cover tends to lower surface temperatures.

Studies of this type are important. It is true, however, that they are, through the complexity of weather factors and the pitfalls of the correlation coefficient, not always final in their result. Nevertheless, each serves a useful purpose in drawing the attention of agriculturists and others to the possibilities of relations or aspects of a subject which are either new or are opposed, as in this case, by a less scientific belief.

C. LeRoy Meisinger

SPECIAL ARTICLES

TRANSFERENCE OF NEMATODES (MONONCHS) FROM PLACE TO PLACE FOR ECONOMIC PURPOSES

Speaking generally, it is now beyond question that many soil-inhabiting mononchs feed more particularly on other nemas. However, they never follow these latter into plant roots, except in the case of open root cavities fairly readily accessible. They do not enter living plant tissues in pursuit of their prey. It follows that the good they do is in devouring the larvæ and young of injurious nemas at such times as the latter are accessible either in the soil or in open cavaties in the roots of plants.

In transferring mononchs from place to place with a view to making use of them in combating injurious nemas, the first requisite is a supply of mononchs. Such a supply may be obtained from soils in which the mononchs are numerous, and although we have comparatively little experience to guide us, yet it is now demonstrated that supplies of mononchs existing under these conditions are available. Thus far these supplies have been discovered more or less by accident; the cases, however, are numerous enough to establish the belief that special search will lead to the discovery of a sufficient number of these original sources of mononchs to furnish an adequate supply for trial.

The methods of collecting the mononchs, and transferring them, once they have been found, have been sufficiently elaborated for practical purposes, and published.

In transferring the mononchs to new situations, it is of course best to pay careful attention to the relative physical and biological conditions of the two habitats—the soil from which they are transferred and that to which they are transferred. The physical and biological conditions of the two habitats should be such as to insure the persistence of the mononchs after they have been transferred from the old to the new habitat. If the climatic and soil conditions of the new habitat closely resemble those of the old habitat, there is every reason to suppose that the mononchs will survive and flourish if there is a supply of suitable food.

The practical details may be illustrated by a hypothetical example. Suppose a region in Holland having a sandy soil has distributed in it as a plant pest the devastating nema, *Tylenchus dipsaci*, which, though more or less prevalent, is not doing very serious damage because held in check by mononchs. Suppose the existence of another region, like that in