The Ecology of Earthworms in Cropland

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Earthworm activity is generally regarded as a negligible factor for influencing the productivity of farm soils. It has been found that the physiological activity of earthworms affects both the organic and inorganic soil fractions, but in a typical cropped field the amount of soil involved by earthworms is generally thought to be minor compared with the total mass of topsoil. Earthworms are thought to occur rather infrequently on ordinary farmland, and to be confined to moist spots or soils that are naturally “rich.” Supposedly, the only way of increasing the earthworm population is the impractical one of adding inordinate quantities of organic material.

Recent information suggests that some reconsideration of these more-or-less accepted ideas may be desirable. Contrary to widespread belief, our studies are indicating that earthworms occur in relatively large numbers in many farm soils. In a Maryland farm soil of quite ordinary fertility, we found as many as ten individuals per square foot, and their total live weight was up to ¼ ton per acre (2). Observations by Slater and Hopp (4), covering a wide area of the Middle Atlantic and North Central states, indicate that the Maryland populations were not at all extraordinary. Determinations of the amount of soil eaten by earthworms also have been made (1). The weight of soil cast per day by earthworms was found to be approximately their live body weight. In view of the apparent magnitude of their activity, the influence of earthworms on cropland can hardly be ignored.

We have also found, contrary to common belief, that the earthworm population is not at all fixed for a locality or soil type. Marked changes are brought about by different systems of cropping. Systems that have long been recognized as harmful to soil productivity, such as continuous row cropping, have now been found harmful to the earthworm population. In the Maryland study (2), the least favorable cropping systems supported a population only about one-tenth as great as the most favorable.

In a later publication (3), it has been shown that the decline in earthworms under cropping is not primarily attributable to organic matter loss from the soil. The decline apparently can be averted with methods that are entirely consistent with ordinary crop removal. By following the earthworm population in continuous and rotation corn, it was found that a sharp decrease occurred at the time of the first heavy freeze in the late fall. In the grain-and-sod phase of a two-year rotation, on the other hand, no decrease occurred. It was found that earthworms were killed by freezing temperatures at this time of the year, so that the decrease could be prevented by insulative protection of the ground surface in the late fall.

The above observation suggested a need for knowledge on the relation of earthworms to the environmental conditions associated with cropping. Accordingly, the study described in the present paper was taken. It is proposed to show that the earthworm population normally follows a well-defined annual cycle, and that the effects of various cropping systems on earthworms are attributable to the manner in which they influence the progress of this cycle. Recognition of these fundamental relations should aid in a more adequate evaluation of the extent and nature of earthworm activity on farmland, and in determining how the earthworm population can be influenced under farming practice.

PROCEDURE

The investigation was conducted on 34 plots located on the Agronomy Farm of the Maryland Agricultural Experiment Station, College Park, Md. Most were started in 1940, and a few in later years. They lay in close proximity to each other, the total area of the plots being approximately 1 acre. The soil was typed as Sassafras loam, but there was considerable variation in texture and depth. However, plots were duplicated and fairly well randomized among the different systems of cropping. The cropping systems included in the study were two-year rotations and continuous cropping to cultivated, drilled, and sod crops, as given in Table 1.

Earthworm counts were made at approximately monthly intervals from February, 1946, to January, 1947, for January, 1947, are transposed in the charts to have the illustrations encompass a single year. Some additional counts were made in April, when cylindrical steel samplers were used during this period. The soil cores were 6.0, 6.6, and 8.0 inches, inside diameter. Three cores were taken on each plot with the largest and four cores with the others. All samplers were only soil to a depth of 7 inches, roughly the plow layer. The soil cores were fragmented, and the earthworms recovered for counting and weighing. Starting with the July 1 sample, earthworms were separated into young and mature individuals, based on their size, the presence of a clitellum, and evidence of sex pores.

Daily temperature and precipitation records were kept on the same farm about a mile distant. This weather station was located in an open field on rather similar topography.

RESULTS

The data were analyzed to determine (a) the nature of the annual cycle in earthworms, (b) the effect of tillage on the annual cycle, and (c) the effect of various cropping methods on the earthworm population. Most of the earthworms were Heloderma lignosum form trapezoides (Savigny) Duges.