TOXICITY OF OVERWINTERED CEREALS *

by A. Z. JOFFE

Department of Botany, Hebrew University, Jerusalem, Israel

INTRODUCTION

This study was undertaken in parts of the Russian Confederate Republic of the U.S.S.R. in order to elucidate the factors conducive to the formation of toxins in cereals that have passed the winter under snow cover. Consumption of such cereals by the population in the Orenburg district and in some other areas of the U.S.S.R. led to serious and frequently lethal outbreaks of a disease designated as septic angina. In Russian this condition is called toxic alimentary aleukia. The disease appeared in 1942, increased considerably in 1943 and especially in 1944 when the food situation deteriorated further and large parts of the population were induced to collecting what grains they could from fields that had been covered by snow throughout the winter months. In this year the total number of cases recorded exceeded that in 1942 and 1943 17.6 and 11.6 times, respectively, and the number of deaths 9.8 and 6.6 times respectively. Thereafter, in 1945 to 47 the disease declined, and it was absent in 1948 and 1949.

At the initiation of the present investigation, attempts were made to induce toxicity in grains of cereals in the laboratory by exposing them to various conditions of humidity, aeration and temperature; cereal grains were also treated with water in which toxic grain samples were washed as well as with pure cultures of

---

* The work described here was carried out in 1943–1950, while the author headed the Mycological Division of the Institute for Epidemiology and Microbiology of the U.S.S.R. Ministry of Health. The results have been written up in 1959 after the author came to Israel and joined the staff of the Department of Botany at the Hebrew University, Jerusalem.
toxin-producing fungi. In these preliminary trials it was found that experiments had to be conducted in nature and on a much larger scale. The mycoflora of overwintered grain plays an active part in inducing grain toxicity. The composition of this mycoflora and the degree of toxicity of its component fungi are discussed elsewhere (Joffe 34).

MATERIAL AND METHODS

For the purpose of this study, 39 experimental plots were set up, under normal field conditions in different counties of the Orenburg district. The plots varied in size from 100 sq. m to 0.5 ha. The experimental crops included the most commonly grown cereals, namely millet, wheat, and barley.

At harvest time the crop from one half of each experimental plot was cut and arranged in stacks, while the other half was left uncut. Samples of the stacked cereals were taken from the upper layer of the stack as well as from the bottom layer, at soil level. Plant and soil samples were usually collected from the experimental plots, twice a month, from August or September of each year to the following May. The samples of cereals were threshed and then dried at 45°C; the soil samples were similarly dried. Samples of dried and threshed grain weighing 30 to 50 g, samples of vegetative parts (stems, leaves, ears, panicles, husks, etc.) weighing 15 to 30 g, and soil samples of not less than 100 g, were soaked in ether or alcohol. After 3 to 5 days soaking with repeated shaking, the ether or alcohol was driven off in a distilling apparatus. The residue obtained after evaporation was assayed for toxicity by application to the shaved skin of a rabbit. The method of testing has been fully described in another paper (Joffe 4). A total of 6,365 tests with cereal and soil samples were performed on 528 rabbits.

At the beginning of each month, a summary was made of the preceding month's weather conditions for each of the experimental plots. These records included:

1. Readings taken at 1:00, 7:00, 13:00, and 19:00 hours of air temperature, relative humidity, and soil temperature at depths of 5, 10, 15, and 20 cm. Soil temperatures were recorded until the establishment of a permanent snow cover.
2. Mean daily maximum and minimum temperatures and minimum temperatures of the soil surface and of the surface of the snow.
3. Moisture content of the upper soil horizon, determined every ten days up to the formation of the snow cover and again at the time of intensive thaw; when snow was present, these measurements were taken only once a month.
4. Amount of precipitation.
5. Depth of freezing of the soil.
6. Average depth of the snow cover, measured every 10 days, and general characteristics of the snow.