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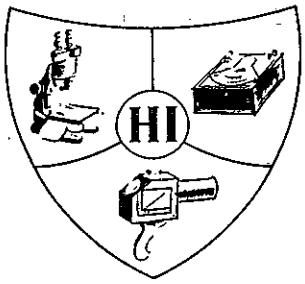
THE SECOND ANNUAL REPORT OF THE BOTANY FIELD STATION

MAY 1, 1951



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THE SECOND ANNUAL REPORT OF THE BOTANY FIELD STATION

by

J. F. Cline and J. W. Porter

May 1, 1951

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ABSTRACT

This report presents data which show that during 1950 the radioactivity of several types of crops, irrigated with water pumped from the Columbia River below the Hanford piles, differed but slightly from that of similar crops grown in a control area.

THE SECOND ANNUAL REPORT OF THE BOTANY FIELD STATION

INTRODUCTION

The history and layout of the Botany Field Station and the results of the first year's operation of this station were reported by Berry and Cline (1). These workers found that soil and crops, irrigated with Columbia River water pumped from below the Hanford piles, did not accumulate amounts of radioactive elements appreciably above those of controls. This finding supported the contention that the operation of Hanford Works does not constitute a hazard to farming operations below Hanford, which require Columbia River water for irrigation purposes.

The present paper reports the results of a second year's operation of the station.

METHODS AND RESULTS

Crops grown and analyzed were beans, oats, sweet corn, potatoes, alfalfa, plums and apples. Cherries and peaches were not available for analysis because of the extremely cold winter of 1949-50. All annual crops were replicated three times on the same experimental plots as used in the preceding year(1), but the crops were rotated among the plots in such a way that each crop was not grown in the plot of soil in which it was grown the previous year. Irrigation water was pumped centrifugally, as in 1949 (1), from the Columbia River and delivered through pipe lines to the desired places for distribution to the crops by the rill irrigation method.

Control crops were not grown at the Botany Field Station during the year 1950. The well to furnish water to these crops was drilled to a depth of 607 feet, but tests of its water producing capacity and installation of a pump were not accomplished by the time it was necessary to irrigate. Therefore, all control samples were taken from the Washington State

College Experiment Station, Rosa addition, Prosser, Washington.

Samples of soil and irrigation water were taken monthly, dried, and counted for beta activity. Samples of vegetation were ashed, with a limited amount of nitric acid, at 600°C. in a muffle furnace and then analyzed for beta activity. Green, dry, and ashed weights were obtained for each vegetative sample.

Yield data for crops were obtained for square yard areas located at random throughout the three replicated plots. Calculations were then made of the amounts of crops by weight per acre.

Table 1 shows the averages and standard deviations for the radioactivity, in microcuries per gram of dry weight, for experimental and control samples. Table 2 shows the variability of radioactivity in soil samples taken from the plots from February through October. Table 3 shows activity densities of soil samples by geometric averages (antilog of the means of the logarithms of the data (2) in microcuries per gram for experimental and control samples. Figure 1 shows the beta activity of the experimental and control irrigation waters throughout the growing season. Table 4 shows the comparison of crop yields of the experimental plots of the Botany Field Station for the years 1949 and 1950.

DISCUSSION

The levels of radioactivity in crops grown in 1949 (1) and 1950 were nearly the same. Likewise, the content of radioactive elements in experimental and control crops in 1950 (Table 1) did not differ appreciably. Comparisons were made difficult, however, by the fact that most of the crops showed a change in content of radioactive elements with a change in the stage of maturity and, secondly, that the control and experimental samples were not taken on the same day.

Trends in variability and content of radioactive elements of experimental and control crops are evident on examination of the data in Table 1. The average content and the standard deviation of radioactive elements

TABLE 1

ACTIVITY DENSITIES OF CROPS FROM EXPERIMENTAL AND CONTROL PLOTS

Sample	Date Sampled	Type of Sample	No. of Samples	Activity Density x 10^6 μc/g. dry wt.	Standard Deviation
Apple (fruit)	8/4	Experimental	19	9.0	2.9
	9/15	Control	14	4.9	3.7
Plum (fruit)	8/2	Experimental	20	4.9	2.8
	8/23	Control	18	8.6	3.9
	9/28	Experimental	17	6.3	5.2
Corn (kernel)	8/18	Experimental	31	20.8	7.6
	9/5	Experimental	29	5.3	2.2
	9/6	Control	20	6.2	3.3
	9/30	Experimental	30	4.3	1.6
Wheat (kernel)	7/18	Experimental	14	7.6	3.5
	7/27	Experimental	6	7.6	1.9
	8/3	Control	20	6.3	3.6
	8/31	Experimental	29	4.1	1.8
Oats (kernel)	7/27	Experimental	12	37.5	22.5
	8/3	Control	21	26.2	4.8
	8/31	Experimental	30	4.2	1.7
Beans (seed)	9/6	Control	20	11.1	1.4
	9/7	Experimental	30	15.0	4.6
	10/16	Experimental	31	13.9	4.9
Potatoes (tuber)	7/18	Experimental	15	8.7	2.4
	8/14	Experimental	22	21.2	6.6
	8/17	Control	20	16.7	6.2
1st cutting alfalfa	5/31	Experimental	10	13.2	7.9
	6/6	Experimental	28	13.6	11.4
	6/14	Control	29	7.1	12.8
2nd cutting alfalfa	7/13	Experimental	20	25.8	9.6
	7/20	Control	20	37.1	12.2
	8/11	Experimental	21	25.7	6.4

TABLE 2

ACTIVITY DENSITIES OF EXPERIMENTAL SOIL IN $\mu c/g. \times 10^5$

Date	Average	Maximum	Minimum	Difference
1-28	1.7	3.6	.66	2.9
2-27	.9	1.8	.36	1.4
3-30	1.6	2.6	.9	1.7
4-27	1.9	2.4	1.0	1.4
5-28	1.9	2.5	.8	1.7
6-30*	2.7	6.7	.8	5.9
7-25*	1.7	2.7	.65	2.1
8-5*	2.1	3.3	.73	2.6
10-2*	2.1	3.1	.66	2.4
10-16*	2.2	4.5	1.4	3.1

* Period of heavy applications of irrigation water.

TABLE 3

ACTIVITY DENSITIES OF SOIL SAMPLES FROM EXPERIMENTAL AND CONTROL PLOTS

Sampling Dates	Type of Sample	No. of Samples	Geo. Av. x 10^5 μc/g.
1/26-4/27	Experimental, before irrigation	89	1.40
6/30-10/6	Experimental, after irrigation	115	2.06
8/17-10/16	Control, after irrigation	60	1.46

TABLE 4

CROP YIELDS OF THE BOTANY FIELD STATION

Crop	Yield 1949	Yield 1950
Alfalfa	3.7 T/A	3.4 T/A
Oats	60.0 bu/A	75 bu/A
Wheat		46 bu/A
Beans	38.5 bu/A	50 bu/A
Corn		133 bu/A
Potatoes	256.6 bu/A	476 bu/A

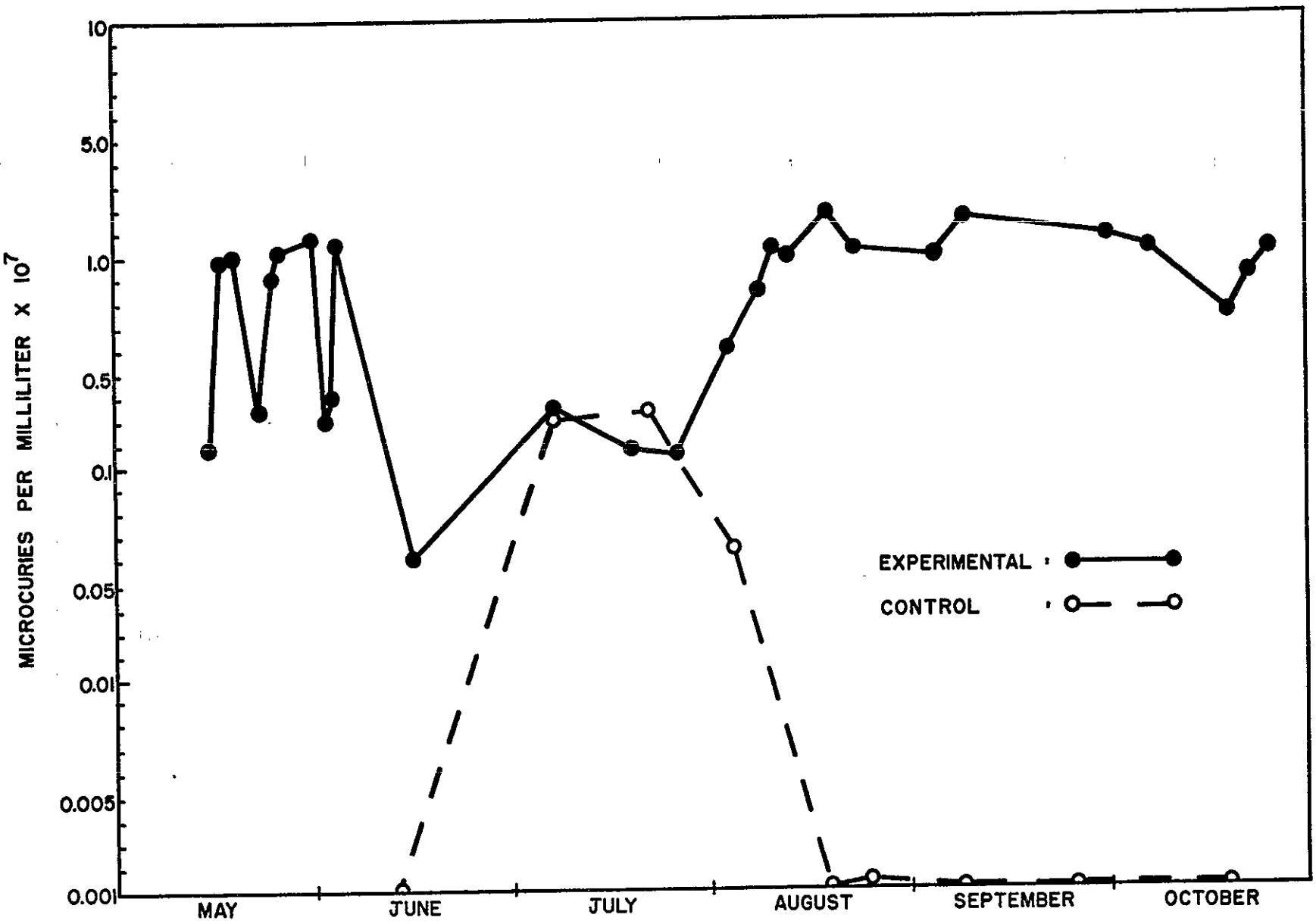

FIGURE I. BETA ACTIVITY DENSITIES OF EXPERIMENTAL AND CONTROL IRRIGATION WATERS

in corn were considerably higher on August 18 than in September. Likewise, the average content and standard deviation of radioactive elements in control and experimental oat samples were much higher in July than August. Samples of wheat contained about the same amount of radioactivity as the more mature samples of corn and oats, but the latter samples were much more variable in content of radioactive elements. The wheat samples showed a slight decrease in average radioactivity content as maturity approached.

During the early stages of development of control and experimental corn, wheat and oats radioactivity densities were considerably higher than at maturity, thus indicating that greater concentrations of a naturally occurring radioactive element were required by the immature than by the mature seeds. That this element may have been K^{40} is indicated by the findings that K^{40} comprises 0.012 per cent of total potassium (3) and that grasses and sages growing in the Hanford Works Area reach maximums, respectively, of 20-25 mg and 30 mg of potassium per gram of dry tissue in May and July. This is equivalent to $1.0 - 1.5 \times 10^{-5}$ $\mu c/g$ dry tissue, which is in the range of values in Table 1.

The experimental bean samples varied considerably more than control samples in radioactivity content, but the average radioactivity densities did not differ appreciably. The average radioactivity content of the first set of experimental potato tuber samples was much lower than that of the later samples. Likewise, the first cutting of alfalfa contained a considerably lower average content of radioactivity than the second cutting.

It would seem from the above paragraph that potato tubers and alfalfa contain greater concentrations of the radioactive element or elements in question as maturity is approached or as the growing season advances. Since control samples did not differ appreciably from the experimental samples in this respect, we are led to suggest the radioactive element in question is probably K^{40}.

The data (Table 2) on the experimental soil show that during heavy irrigation, there was greater variability among individual samples. This may have resulted from a higher application of water at the head of the irrigation rills, and a resultant greater adsorption of radioactivity by soil particles at the upper end of the plots.

The radioactivity of the soil (Table 3) also increased after river water was applied. Up to this time the experimental samples had the same activity as the control samples. This finding is probably explained by the fact that most of the radioactive elements present in river water are short-lived and decay to nearly background between irrigation seasons.

Crop yields (Table 4) with the exception of alfalfa, were above the average yields of Central Washington (1). The first cutting of this crop was not included in the yield figure which accounts for the low yield of alfalfa. There was some increase in crop yield for 1950 as compared with 1949. This was probably due to better irrigation and fertilization practices.

The radioactivity of the experimental irrigation water (Figure 1) was similar to that of the previous year (1). Control water samples gave counts either in the background range of the counter or only slightly above the background range.

SUMMARY

The second year's operation of the Botany Field Station showed no significant increases of radioactivity in soils or crops over that of the previous year. There were only minor differences in activity densities between experimental and control crops, and none was sufficiently high to cause concern over the use of Columbia River water for irrigation purposes.

The content of radioactive elements in experimental and control

crops varied with the date of sampling and the crop sampled.

The content and variability of radioactive elements in the experimental soil increased during periods of heavy irrigation, but the major portion of these elements decayed before the next growing season.

Crop yields, with the exception of alfalfa, were above the average yields of central Washington.

ACKNOWLEDGMENT

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BIBLIOGRAPHY

1. Berry, E. C. and J. F. Cline, "First annual report of the botany field station", Document HW-16056 (1950) (CONFIDENTIAL).
2. Bennett, C. A., "Statistical analysis-uptake of radioactivity in field crops", Letter, January 17, 1951, Statistical Group, Technical Services Division, General Electric Company.
3. Singlevich, W., "Personal communication".

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