The Influence of Radioactive Fallout on Agronomic Field Experimentation with Radioisotopes[1]

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Radioisotopes, such as phosphorus 32, are frequently used in agronomic field experiments. The success of the experiment depends in part upon the elimination of significant ionizing radiations from other sources. Any external source of ionizing radiation increases the likelihood for error, and makes it much more difficult to detect and measure small differences due to treatment. Plant material normally contains small amounts of radioactivity, but the amount is generally insignificant in relation to the amounts normally used in biological experiments.

In a band fertilization experiment on soybeans conducted at the Purdue Agronomy Farm in the summer of 1957, an external source of ionizing radiation was discovered. The soybean treatments in this experiment were sampled at approximate weekly intervals starting on July 11, 1957. In the second sampling on July 16, 1957, approximately 15 untreated plots showed activity 15 to 18 times normal background. This high activity in the experimental plots was unexplainable on the basis of experimental design or technique. The possibility of contamination due to experimental technique was thoroughly examined, and found to be practically non-existent. The possibility of untreated soybean plant roots feeding upon fertilizer placed in adjacent rows was discounted since equally high activity was observed outside the experimental area in corn, weeds, and soybeans. Since there was little activity present in the first sampling on July 11, and very high activity discovered in the second sample on July 16, it is assumed that the radioactivity was associated with the 1.86″ rainfall which occurred on July 13, 1957.

The high levels of activity encouraged the collection of samples when convenient during trips around the state. Sixty-four soybean samples collected for a soybean nutrition survey were also used in measuring the distribution of fallout in the state. The soybean samples in this survey were taken from an area approximately 50 miles wide, extending from Walkerton to Evansville, Indiana. These plus other miscellaneous plant samples from Indiana, Kentucky, Michigan, and Wisconsin were used to determine the magnitude and probable areas of fallout in the state, its half-life, type of ionizing radiation, and the approximate energy of its radiation. Table I shows the plant sample activities corrected to July 31, 1957. The range of activity of these samples ranged from practically none in Northern Indiana to very high around Lafayette, Indiana; Louisville and Henderson, Kentucky; Patoka

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TABLE I
Plant Sample Activities (Counts per Minute)[1]

Number of Samples	Plant Species	Location	Date Collected	Date Counted	Range of Observed Count	Average Counts per Minute	Average Counts per Minute Corrected to July 31, 1957
15	Soybeans	Purdue Agronomy Farm	July 16, 1957	Aug. 22, 1957	204-286	242	460
34	Soybeans	North to Walkerton From Lafayette, Ind.	July 31, 1957 Aug. 1, 1957	Sept. 5, 1957	2-29	14	---[2]
30	Soybeans	South to Evansville From Lafayette, Ind.	Aug. 28, 1957 29 30	Sept. 5, 1957	21-100	57	143
6	Soybeans Ragweed Corn	Indianapolis to Lafayette, Indiana—Highway 52	July 25, 1957	July 31, 1957	112-263	200	200
4	Quackgrass Corn	Hart and Lansing, Michigan	Aug. 22, 1957	Sept. 2, 1957 Sept. 17, 1957	9-26	16	---[2]
2	Sugar Beets Corn	Chilton, Wisconsin	Aug. 27, 1957	Sept. 2, 1957	12-26	19	---[2]
2	Soybeans Corn	Near Louisville, Ky.	July 28, 1957	July 31, 1957	93-276	185	185
1	Soybeans	Hopkinsville, Ky.	Aug. 30, 1957	Sept. 2, 1957	15	15	---[2]
1	Corn	Owensboro, Ky.	Aug. 30, 1957	Sept. 17, 1957	73	73	220
2	Corn Ragweed	Purdue Agronomy Farm	July 21, 1957	Aug. 20, 1957	159-273	216	404

[1] Activity measured in an infinitely thick sample briquet, 1 inch in diameter, placed approximately one centimeter from window of Traceslab TGC—1 Geger tube.

[2] Activity below 30 counts per minute assumed to indicate negligible fallout.

and Rockville, Indiana. It appears from an examination of the rainfall on July 13th and sample activity that the amount of fallout was roughly proportional to rainfall.

The half-life characteristics of the fallout were separated into two groups, one of 18.3 days and the other 38.2 days. Since this undoubtedly was a mixture of isotopes, these half-life groups were of no value in identifying the radioactive isotopes in the mixture. The type of particle emitted was found to be predominantly beta, with probably very small amounts of weak gamma radiation. The beta particle was assumed to be negatively charged. The energy of the beta particle was determined as approximately 1.5 Mev and 1.6 Mev in two different determinations approximately two months apart. Its energy was slightly less than that of phosphorus 32. Identification of the components of the mixture was not considered within the scope of the project.

The contamination of an isotope tracer experiment is serious, particularly when the type and energy of ionizing radiation emitted is so similar to that emitted by phosphorus 32. Contamination must be considered in the analysis of the treatment differences. This means the determination of a correction factor to account for the ionizing radiation due to external sources, or fallout.

The experimental work on the fallout's effective half-life indicates that the material is sufficiently long-lived to influence activity measurements over a period of several months after its formation. This emphasizes the necessity for continuous monitoring by measuring the level of activity in the check plots.

With the increasing use of nuclear energy, nuclear weapons testing, and nuclear experimentation, it will be especially necessary to be on the alert for this new variable in all field experiments with radioisotopes. The properly designed experiment will provide a means for controlling or minimizing the effect of fallout on field experimental data.