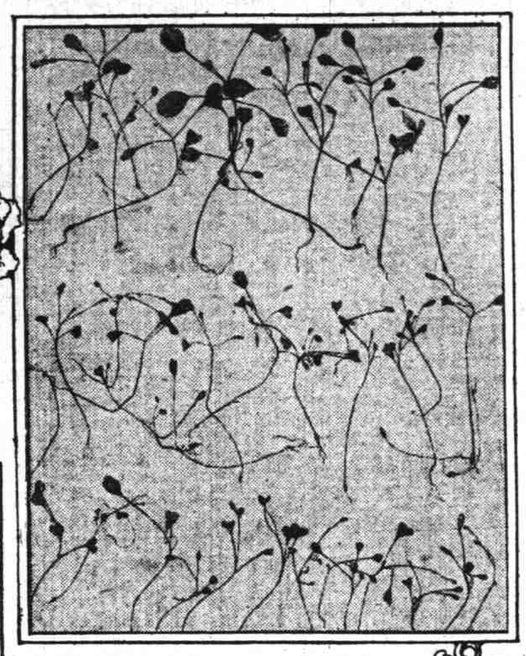
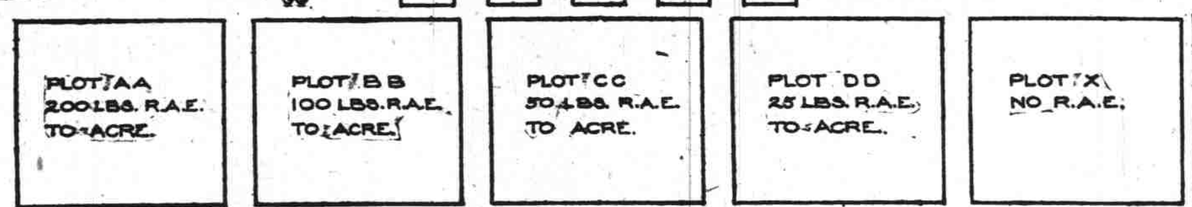
RADIUM A WONDERFUL STIMULANT OF FARMERS' CROPS

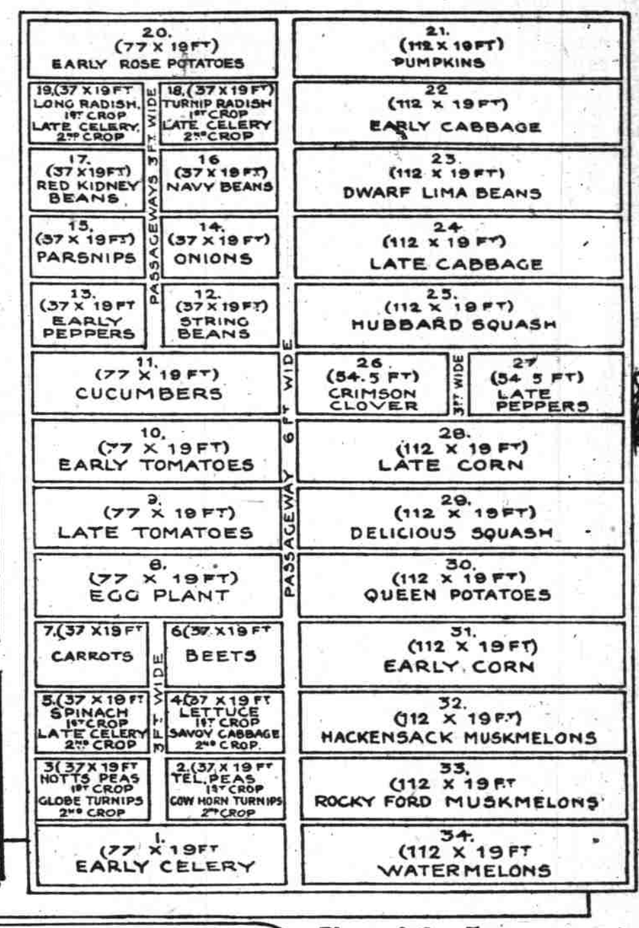
Tests Show That the Yield of Many Vegetables Is Much Increased by Its Use and That the Quality Is Improved. Flowers and Lawns Benefited

Dr. Murray H. Rusby





Plan of Portion of Nutley Farm.



Plan of the Farm.

Dr. H. H. Rusby, the author of the following report, here published in part for the first time, has been officially recognized by the Bureau of Chemistry at Washington as the greatest living authority on the indentification of plants. Dr. Rusby is the Dean of the Columbia University College of Pharmacy and is Federal Pharmacognosist at the Port of New York. He was for a time the centre of the storm that raged in the Department of Agriculture two years ago and which nearly resulted in the overthrow of Chief Chemist Harvey W. Wiley. Dr. Rusby's prompt exposure of the plot against Dr. Wiley saved the situation.

By H. H. Rusby, M. D.

UP to the time of the discovery of radium anthracite coal represented about the highest known degree of stored energy. Radium is now believed to embody 360,000 times the energy of anthracite coal. The energy of radium is, however, of a totally different kind from that of coal. The energy of coal and other ordinary substances is exerted by the atoms of which they are composed; that of radium, by the separation of these atoms into smaller bodies and the liberation of the energy of these particles.

As a result of this great difference, radium can perform work only of a totally different character from that performed by ordinary substances. It is the dream of the physicist to discover a method by which the energy of radium can be exerted without this dissolution of its atoms, the effect of which would be revolutionary in the mechanical world.

It has been claimed by some French investigators that they have already solved this problem, and that they have found several ways of applying radium in the performance of mechanical work, but the claim appears improbable. So far as the scientific world now knows, the effects of radium are wholly exerted by the separation of its atoms into inconceivably minute bodies of three kinds, which dart off with extreme velocity, penetrating and passing through almost all substances and producing their effects as they go.

In October, 1913, I arranged with the Standard Chemical company of Pittsburg Pa., to make preliminary trials on an extensive scale. In view of the cost of radium and its preparations, the reader may wonder how such an experiment could be undertaken. It requires about 400 tons of radium ore of standard quality to yield a gram, about 15½ grains, of radium, which amount could easily be carried on a man's thumb nail. The regular market price is $10,000 a grain, or $120,000 a gram, equal to $70,000,000 a pound. This problem was solved by making use of the finely powdered residue remaining after all the radium possible has been extracted, but leaving some two or three milligrams to the ton, worth some $300, yet a by product unless a special use for it could be discovered.

Big Increase in Production.

That the application of such material to the soil is a profitable procedure for the gardener or farmer may be understood when it is seen that such increases in production resulted as 29 per cent in lettuce, 17 per cent in lima beans, 35 per cent in cucumbers, 35 per cent to 44 per cent in different varieties of squash, 80 per cent in Rocky Ford muskmelons, 24 per cent in carrots, 50 per cent in sweet corn, and 70 per cent in radishes, and that nearly all vegetables are wonderfully improved in their table qualities. Lawns are benefited to an equal extent, and the size and brilliancy of garden and hot house flowers is remarkably increased.

My experiments and observations included the winter culture of radishes in a market gardener's greenhouse, some seedlings in window boxes in my own home; field crops covering more than 100 acres at Northfield, Ohio, under the direction of W. W. Darling; an experimental garden at Pittsburg, and the plantation of an acre and a half at Nutley, N. J., of which I have had immediate personal charge throughout the season.

The greenhouse radishes were already about an inch high when the radium was applied. A furrow was scratched midway between the rows, which were four inches apart, and the powder sowed therein at the rate of 16 grains to the square foot, which is equal to about 50 pounds to the acre. A square yard was thus treated and was compared with an exactly similar square yard upon the same bench, about 10 feet distant. The radium radishes soon appeared much inferior to the others, and continued to do so to the end of the experiment, the tops being smaller, as though stunted, but on harvesting and weighing the green tops and the roots separately, the tops were found to weigh 17 per cent less from the radium plot than from the other, while the radishes weighed about 20 per cent more.

Huge Economy.

The season of growth had been very bad, February being very stormy, with little sunshine, and that little largely excluded by snow lying upon the glass roof. This observation is of much importance, indicating that it required less green leaf surface under deficient sunlight for the plant to manufacture a larger amount of food for deposit in its root. It will later be seen that various other experiments indicate and elucidate this principle.

For the grower of winter market produce under glass, who suffers from insufficient sunlight and is obliged to maintain a great amount of leaf-tissue in order to secure a moderate production of nutriment, the use of such a stimulating material will mean a huge economy.

Both of my window boxes were filled from the same pile of soil, similarly treated in every way except that in one the above mentioned amount of radium earth was mixed through the soil. All operations were conducted for both boxes at the same time. Their positions in the window were exchanged from time to time, so as to preserve absolute equality of conditions. In the boxes I sowed cabbage and tomato seed in alternate rows. The seeds germinated one or two days earlier in the radium box and the plants were already well developed when those in the other box broke through the ground. The difference was more marked with the cabbages than with the tomatoes. The original lead of the radium plants continued to increase throughout the experiment, and after some two months, when the experiment was brought to a close, a given number of plants in the radium box would have weighed from six to 10 times as much as from the other.

In Mr. Flannery's garden I particularly noted the great gain of turnips and beets under the radium influence over those without it. Radishes, which I did not myself see, were said to have yielded more than 100 per cent increase under the radium treatment. The quality of the radium grown vegetables was a matter of special comment by all who tried them, and this has proved true of all vegetables raised elsewhere under this treatment.

Operations at the Northfield farm were greatly handicapped by the heavy rains of March, April, and May, which delayed planting for more than a month beyond the proper time, and which later drowned portions of the crops in low places. Later severe drought caused further injury. Many of these results are, therefore, not yet available, but the growing crops, which I have observed with great care on various occasions, have shown results in all respects similar to those recorded at my Nutley plantation, which I shall now describe.

Corn produced with (right) and without (left) R.A.F.

Successful Experiments.

The powdered radium ore tailings were applied to the land in the proportion of about 25, 50, 100, and 200 pounds, respectively, to the acre. This meant, on plots of 5 by 20 feet, only one, two, four and eight ounces, amounts inconveniently small for uniform distribution. Therefore, to each such portion eight ounces of ordinary fertilizer was added and very thoroughly mixed by steam power. This mixture made of the tailings, a sort of radio-active fertilizer, for which the symbol R A F will here be used, although the figures stated will actually represent the amount of the tailings contained therein.

A field having an area of one and one-half acres was secured and surrounded by a high fence to prevent possible interference. Half of the ground formed a gentle slope to the east, the remainder occupying the level above. The ground was a light, decomposed sand-shale and was moderately stony. Through this plot, from east to west, was laid a road six feet in width. On one side the strip was 114 feet wide, on the other 78 feet. The whole was divided into 34 sets, each set consisting of five plots.

One plot, AA, was treated with R A F at the rate of 200 pounds to the acre; another, BB, with 100 pounds, a third, CC, with 50 pounds; DD, with 25 pounds, and X, with none. Each set of plots was 19 feet wide, and the plots composing the sets were, respectively, five, thirteen, nine or 20 feet by 19 feet, according to the nature of the crop. Each plot was separated from those on its four sides by paths three feet wide, except for the central road, which was six feet wide. As will be seen from what follows, this three feet was too narrow a separation to prevent the rays of the radium from reaching every plot on the tract and modifying its yield.

Each plot of a series received exactly the same amount of the same kind of fertilizer applied at the same time and in the same way. Every operation of seeding, hoeing, cultivating, etc., was performed across all five plots at once. Thus, if rain or other condition caused interruption, no plot would have any advantage or disadvantage as to time over any other. In short, absolutely no differences existed in the conditions affecting the growth of plants in the five plots of a series, except as to the amount of R A F that was applied.

In all but one case, the R A F was sowed equally over the surface and then dug in. In this one case part of it was put in the rows in order that a comparison of results might be obtained. When some of the early crops were harvested, the ground was again dug, and other crops planted. More fertilizer was then applied, but in no case was any more R A F added. The R A F in the soil was, however, much more thoroughly distributed by this second digging.

Effect on Turnips.

That the three foot path was not sufficient to prevent the emanations from crossing and affecting the adjoining plots is fully proved by the observations which follow. A 5 by 19 foot plot of turnips, not treated with radium, lying just north of one treated with 25 pounds R A F to the acre and having the rows running north and south, shows the plants at the southern end of each row, and, therefore, separated by only the three foot path from the 25 pound plot, twice as large and strong as those at the northern ends. The graduation in size from the large to the small plants, in all 10 rows, is almost as regular as though produced mechanically. There is an exactly similar difference among the turnips in the 25 pound plot, those at the southern ends of the rows, separated by three feet from the 50 pound plot, being twice as large as those at the northern end, with the same regular gradation. Between the 50 pound and the 100 pound plots there is little difference, showing that 50 pounds produces about the maximum effect on turnips.

Conclusive Results.

Between the 100 and the 200 pound plots, however, there is a similar but reversed relation. The turnips in the 200 pound plot are stunted by an excess of radium, just as was the spinach that occupied the same plot in the early spring. Now, the plants in the 100 pound plot, lying across the path from the 200 pound plot, are similarly stunted, while their size increases regularly from that side to the north side, where they are as large and fine as in the adjoining fifty pound plot. In the series of plots next to the west, the celery plants show exactly the same series of differences as do the turnips.

Had I performed no other experiments than these this year, I should have regarded the results as conclusive, since there is no other possible cause for the differences in the plants than the effects of the different amounts of R A F. It is in this way that I explain the wide difference in the extent of the gains by R A F at the Northfield farm and those at Nutley. At Northfield the plots compared are acres in extent, so that radio-activity from one could affect only a very narrow strip of the other, and the difference in weight of crops would show the full difference in activity of the radium. At Nutley, on the other hand, no plot, even though no R A F was applied, was entirely free from radium influence, which increased its yield above the normal, and decreased the differences between it and the radium treated crops.

All these results are permanently and indisputably recorded by a series of photographs, which display with great accuracy minute differences between the respective plots.

In the accompanying table each plot is indicated by the number of pounds of R A F that it received to the acre. It will be observed that no plot received less than 25 pounds, while at Northfield the plot with the least R A F, namely D, received 12½ pounds to the acre. On the other hand, none at Northfield received more than 100 pounds (A), while at Nutley A A represents 200 pounds to the acre.

Some Important Experiments.

The results of experiments with turnips are of greater interest and perhaps of greater importance than any other secured. Two varieties were planted, one the cowhorn, which produces a long slender root like a carrot and the other the white globe, producing a short rounded root, half or more of it borne above the surface of the ground. These varieties were selected in order to ascertain whether the longer variety would show a greater effect from the action of the radium, as I had previously found true of long radishes as compared with small round ones, in which case the latter showed only 2 or 3 per cent increase over the control plot, while the former showed 70 per cent in merchantable radishes and 40 per cent in total.

In the case of the globe turnips I collected 11 pounds from the control plot and 15 from the BB plot, a gain for the latter of about 36 per cent. In the case of the long turnips, I harvested 14 pounds from the control plot and 32 from BB, a gain of about 129 per cent. These two instances go far toward indicating that the larger the amount of root buried in the soil, and thus exposed to the action of the emanations, the greater will be the gain in that crop. This result agrees with theoretical considerations. It has been established that the entire plant, and more especially the root, becomes radio-active and that this activity resides in the contained water, which would naturally impart a greater activity to that one with a larger root surface buried in the soil, where it can absorb the radio-active water, this water continuously stimulating all the cells with which it is in contact.

Other Interesting Data.

There are other interesting considerations in this case. The season of turnip growth, from late August to middle October, was this year marked by an almost total absence of rain, so that the crop was practically a failure. At the time of collection, October 15, the foliage on the control plots was completely dead and dry. The BB plot of cowhorn turnips was almost as bad, while the other three, especially the AA plot, were successively less damaged, having more or less green foliage and being still in a growing state. Therefore, had the time been extended, the percentage of gain over X would have been still greater than that now recorded. On the other hand, the conditions and the results are now abnormal, and we probably could not expect such large differences under ordinary conditions.

Some little light has been thrown upon the effects of radium upon plant diseases. The early part of the season was very wet, and the tendency to blight in cucumbers, squashes and muskmelons, to smut in sweet corn, and to fruit rot in eggplants and tomatoes was rather marked. The damage in the radium-treated plots was not the same in the different crops. Cucumbers and squashes appeared to suffer most where there was most radium, the melons where there was none. Early corn (Golden Bantam) suffered about twice as much from smut where there was most radium as where there was none, while late corn (Country Gentleman) showed little difference in the different plots.

Tomatoes and eggplants suffered very little from rot on the heavily treated plots, but severely where there was little or no radium. In the case of eggplants the ratio of damage on the different plots ran almost exactly the same, but inversely, with the amount of radium applied.

In conclusion, it may be stated that the yield of most crops can be increased by the addition of some amount of R A F, the amount differing with different crops. The beneficial effects continue over successive crops, probably for many years. The largest amount required by any crop would cost less than the increased market value of such crop of the first year.

The most satisfactory results will be in greenhouses, in winter crops raised in the south, in the kitchen and flower gardens, and on the lawn. The quality of vegetables is improved even more than the yield. The gain will be largely increased where irrigation is possible.

Radium is not a plant food. The necessity for fertilizer is but little decreased by its use. The fertility of unused ground will spontaneously increase at a much greater rate when treated by radium.

TABLE SHOWING POUNDS PRODUCED FROM PLOTS OF LAND VARIOUSLY TREATED.

	AA. *200 Lbs. R. A. F.	BB. 100 Lbs. R. A. F.	CC. 50 Lbs. R. A. F.	DD. 25 Lbs. R. A. F.	X. No R. F. A.	Pc. of Increase Over X. AA.	BB.	CC.	DD.	X Over Next Test.	
Telephone peas	20.9	21.15	23.11	19.4	22.	...	...	8.	...	...	
Nott's peas	13.11	16.	15.2	20.6	16.10	...	...	...	22.5	...	Leguminosae
String beans	33.10	35.2	32.7	30.14	31.11	...	11.	...	...	...	
Lima beans	68.	92.	81.5	93.	79.5	...	...	...	17.	...	
Lettuce	32.12	31.	26.12	34.5	26.9	...	...	...	29.	...	
Spinach	4.3	9.12	11.14	16.1	15.5	...	...	...	5.	...	Chenopodaceae
Beets	133.	132.	133.	126.	133.	All equal.					
Potatoes	48.	56.	65.	68.	61.	...	...	...	8.2	...	
Early tomatoes	181.	270.	300.	293.	330.	...	...	...	...	7.	
Late tomatoes	169.	†228.	242.	213.	267.	...	...	...	...	10.	Solanaceae
Egg plants	160. (1.9 ea.)	160. (1.7 ea.)	118. (1.7 ea.)	120. (1.9 ea.)	153.	4.5	4.5	...	...	...	
Early peppers	14.	28.	24.	28.5	29.	...	...	...	...	3.6	
Late peppers	18.5	16.	13.	12.5	13.	42.	...	...	...	...	
Cucumbers	8.15 (5 oz. ea.) 4.15 small	7.7 (3.8 oz. ea.) 5.8 small	9.12 (4.5 oz. ea.) 4.14 small	10.1 (3.8 oz. ea.) 3.15 small	7.14 (4 oz. ea.) 5.10 small	...	...	...	35.7 5.4 total	...	
Pumpkins	277. (6.9 ea.)	243. (6.4 ea.)	321. (7.1 ea.)	222. (6. ea.)	206. (5.1 ea.)	...	...	56.	...	...	
Hubbard squash	185. (7.7 ea.)	232. (8. ea.)	150. (200) (6.8 ea.)	100. (133) (6.7 ea.)	161.5 (7.7 ea.)	...	44.	...	...	...	Cucurbitaceae
Watermelons	370. (19. ea.)	340. (9.75 ea.)	378. (11.33 ea.)	353. (8.12 ea.)	269. (8.25 ea.)	...	...	27.7	...	...	
Delicious squash	217.	233.	226.	258.	188.	...	...	...	35.5	...	
Hackensack melons	87.	103.	116.	68.	73.	...	...	59.	...	...	
Rocky Ford melons	39.	83.	72.	50.	46.	...	80.	...	...	...	
Turnip radish	54.1	57.4	64.10	66.10	64.7	...	40.	...	2.5	...	
Long radish		51.3	78.1	70.5	58.	...	70.	...	...	...	
Early cabbage	384. (3.2 ea.)	412. (3.4 ea.)	388. (3.1 ea.)	280. (3.3 ea.)	349. (4. ea.)	...	18.	...	...	...	Cruciferae
Late cabbage	460. (4.8 ea.)	404. (4.6 ea.)	458. (4.7 ea.)	420. (4.3 ea.)	405. (4.4 ea.)	13.6	...	...	...	...	
Late corn	81. (0.55 ea.)	80. (0.6 ea.)	90. (0.56 ea.)	95. (0.61 ea.)	63. (0.42 ea.)	...	...	...	50.	...	
Early corn	95. (6 oz. ea.)	92. (5.3 oz. ea.)	90. (5.7 oz. ea.)	95. (5.5 oz. ea.)	88. (5.5 oz.)	8.	...	...	8.	...	Gramineae
Carrots	85.	104.	138.	118.	111.	...	...	24.	...	...	

*R A F means radio-activa fertilizer.