E. M. Romney, H. Nishita, and A. Wallace

Transfer of Radioactive Fallout Debris from soils to humans investigated

Contamination of agricultural soils and crops by radioactive by-products of nuclear fission is under continuing study.

The relative hazard that could arise from the numerous radioactive elements depends largely on the individual radioisotopes accumulated in the human body by transfer through the soil-plant-animal-man food chain.

To study various factors influencing the movement of certain medium- and long-lived fission products in soils—and the uptake of those products by plants—crop plants were grown in clay pots containing a mixture of soil and radioisotopes. In actual cases of soil contamination by fallout debris the radioactive material is limited to the top layer of the soil, except where the soil has been plowed after fallout has occurred.

Strontium90

Different plant species showed varied capacities for accumulating strontium90 from the soil. Generally, the material was more concentrated in the leaves than in other parts of the plant. Relatively low levels of strontium90 accumulated in the grain and fruit of most crop plants, in comparison to the high levels in foliage.

Soil type also affected crop uptake of strontium90. The highest concentration levels were in plants grown on acidic soil that is low in native calcium supply. Much lower concentration levels were found in plants from calcareous soils. Studies of intensive cropping over periods of from 45 days to 120 days showed that most crop plants removed only portions of the soil concentration level of certain significant medium- and long-lived fission products: 5%–10% of strontium90; 0.01%–0.30% of yttrium-91; 0.05%–0.13% of ruthenium106; 0.10%–0.50% of cesium137; and 0.01%–0.05% of cerium144.

In fixation and extractability studies, strontium90 assumed varying degrees of availability in different types of soils. In these studies the water soluble and the exchangeable fractions were presumed to be readily available to plants. Highest levels of available strontium90 were in acidic soils low in clay and mineral nutrient content. Crop uptake of strontium-90 was inversely correlated with the level of available calcium in the soil.

In studies with soil amendments to reduce crop uptake of fission products, the addition of organic matter—at levels greater than 10 tons per acre—reduced strontium90 uptake during the mineralization of noncomposted organic materials.

The addition of calcium fertilizer amendments—2–5 tons per acre—re-

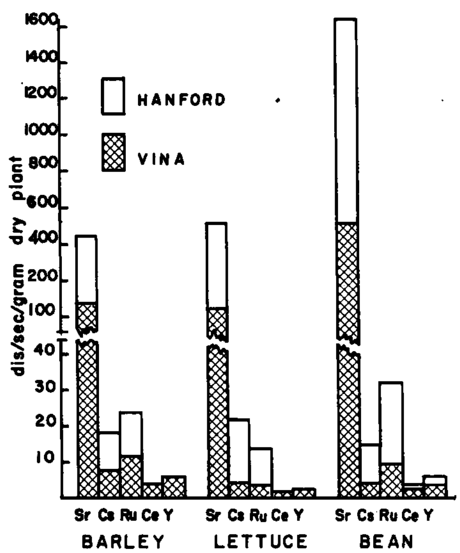
Continued on page 14

Accumulation of Strontium90 in Plant Parts Grown on Hanford Sandy Loam*

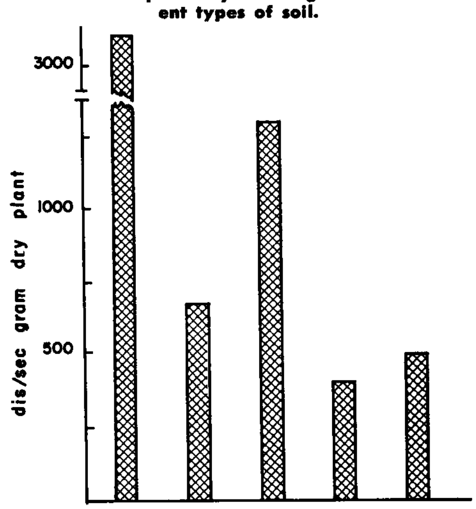
Plant part	Strontium90 dis/sec/gram*
Barley	
Forage	632
Grain	190
Bean	
Leaf	1,618
Stem	820
Fruit	320
Carrot	
Top	910
Root	297
Lettuce	
Leaf	757
Stalk	424
Radish	
Top	2,020
Root	647
Potato	
Top	3,136
Tuber skin	19
Tuber	72

* Soil contamination = 100 disintegrations per second per gram.

Crop uptake of strontium90, yttrium91, ruthenium106, cesium137, and cerium144 from Hanford sandy loam and Vina loam.

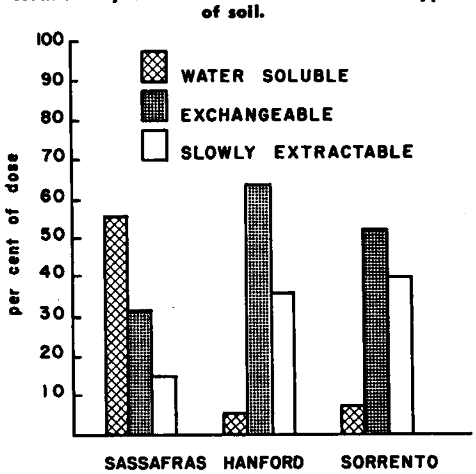


Strontium90 uptake by beans grown on different types of soil.



Soil Series	Sassafras	Vina	Hanford	Yolo	Sorrento
pH	4.6	6.4	7.0	7.8	8.0
C.E.C.(me./100g)	6.03	14.25	8.22	19.58	15.10
Exch. Ca "	0.40	8.20	4.50	7.20	12.44

Availability of strontium90 from different types of soil.



MEASUREMENT

Continued from preceding page

desired pressures are observed using a mercury U-tube and a meter stick calibrated in millimeters.

The pressure-membrane unit—the high pressure system—was constructed so control valves would allow the operator complete freedom to direct air from any pair of regulators to any or all of the pressure-membrane units at three separate pressure ranges.

Air pressure for both units of the pressure panel is supplied by a two-stage compressor with a capacity of 300 pounds per square inch working pressure. A maximum pressure of 30 pounds per square inch is required for the porous-plate unit and a maximum pressure of 217 pounds per square inch—equivalent to 15 bars—is required for the cellulose membrane unit.

A graph plotted from typical soil-moisture suction curves for four different soils demonstrated the effect of particle size on the soil moisture characteristics. The greater the number of small particles such as in clay loam, the greater the quantity of water that can be stored and be available for plant growth.

Eugene R. Perrier is Laboratory Technician in Irrigation, University of California, Davis.

James M. Davidson is Laboratory Technician in Irrigation, University of California, Davis.

William R. Johnston is Assistant Specialist in Irrigation and Soil Science, University of California, Los Angeles.

GOPHER BAIT

Continued from page 7

the coulter diameter and sharpness, the weight of the unit, and soil conditions.

In development tests, the greatest improvement in soil penetration resulted from lowering the rear attachment point of the upper link to make this link about parallel with the lower links. This adjustment reduces the upward pull on the shank. Raising the lower-link attachment pins on the tool frame also improved penetration, but the amount that these hitch points can be raised is limited by the amount of ground clearance needed when the tool is fully raised.

Rolling coulters must be forced into the ground. In tests in an old pasture with moist soil and fairly heavy sod, the total downward force required for 5″ penetration was 380 pounds for an 18″ coulter but only 220 pounds for a 16″ coulter. The 16″ size is adequate for the mechanical gopher.

Objectives in the development of the burrow-forming shank included penetrating ability, obtaining a clean burrow, effective closure of the slot above the burrow, shedding trash, and minimizing soil heaving and surface disturbance. Replaceable spear points used on three of the tested shanks gave good penetrating ability with less soil heaving and surface disturbance than other points tried.

The current model shank is curved forward so roots collected below the coulter level tend to slide upward to the surface and usually fall off during operation or when the tool is raised. This shank has an over-all body thickness of 5/8″ and was built up by adding a bait passage and burrow-forming side pieces to a commercially available spear-point cultivator shank. A deflector at the lower end of the bait tube discharges the poisoned bait rearward about 3/4″ above the bottom of the burrow, thus leaving the bait on top of any cave-in dirt.

The bait-metering device on the applicator shown in the lower left photograph is the conventional plate-type seed hopper with corn base. The 16″ presswheel and the drive components are from a McCormick No. 184 tool-bar-type planter. A flat rim was clamped around the presswheel. A 5/16″ seed plate with 12 round-hole cells 5/8″ in diameter is suitable for applying grain baits at rates of 2–4 pounds of grain per 1,000′ of burrow. Application rates can be adjusted by changing the speed ratio between the presswheel and the plate.

To obtain good burrows the soil must be moist but not sticky—in good plowing condition—and must be reasonably firm. The operating depth should be adjusted so the artificial burrows will intercept a maximum number of gopher burrows. Careful alignment of the coulter blade with the shank minimizes disturbance of surface soil.

Although a shear bolt protects against damage if the shank hits an obstruction, forward speeds should not exceed 3½–4 miles per hour and should be slower where there is an obstruction hazard. At 3½ miles per hour and with burrows 20′ apart, 6–7 acres per hour can be treated.

Total construction and assembly time in a well equipped shop should be 25–30 hours. The costs for all construction materials and purchased parts or assemblies, including an adjustable upper link for the three-point hitch, the presswheel, seed hopper and drive assembly, and the rolling coulter, total approximately $130.

Although the preliminary field trials indicate definite possibilities for the mechanical bait applicator in the control of pocket gophers, many more tests are needed to determine the most acceptable bait, the best amount to use, and the most efficient spacing of the artificial burrows under various field and gopher-population conditions in California.

R. A. Kepner is Professor of Agricultural Engineering, University of California, Davis.

W. E. Howard is Specialist, Field Station Administration, University of California, Davis.

The above progress report is based on Research Project No. 1804.

Additional field trials with mechanical bait applicators are planned by many California County Farm Advisors.

Detailed construction plans for a mechanical gopher-bait applicator and operating instructions may be obtained without cost from the Department of Agricultural Engineering, University of California, Davis.

The mechanical baiting experiments in Colorado are reported in Special Scientific Report: Wildlife No. 47, 1960, *by A. L. Ward and R. M. Hansen, U. S. Department of Interior, Fish and Wildlife Service, Washington 25, D. C.*

FALLOUT DEBRIS

Continued from page 6

duced to about one fifth the amount of strontium90 taken up by plants from acidic soils. Added calcium did not significantly reduce strontium90 uptake from neutral soils of high calcium status or from alkaline-calcareous soils. Crops grown on soils of high calcium status take up only about one tenth the amounts of strontium90 taken up from soils of low calcium status.

The addition of stable strontium amendments to soils at levels compatible for normal plant growth did not effectively reduce strontium90 uptake. There was reduced crop uptake of strontium90, ruthenium106, and cerium144 when high concentrations of bicarbonate were present, as is usual in alkaline and calcareous soils.

The extent to which strontium90 accumulates in the human body through the soil-plant-animal-human food chain apparently depends on the dietary calcium accumulation, because calcium tends to dilute the strontium90 concentrations.

Cesium137

Cesium and potassium also showed complementary ion relationships. Crop uptake of cesium137 increased as the potassium level in the soil was reduced by cropping. The addition of potassium amendments reduced plant uptake of cesium137 from soils low in exchangeable potassium content but not from soils with high levels of available potassium. Crop uptake of cesium137 was inversely correlated with the level of available potassium in soils.

The addition of stable cesium amendments to soils was ineffective in reducing cesium137 uptake even when applied at levels that were toxic to the plant.

E. M. Romney is Assistant Research Soil Scientist in the Laboratories of Nuclear Medicine and Radiation Biology, School of Medicine, University of California, Los Angeles.

H. Nishita is Assistant Research Soil Scientist in the Laboratories of Nuclear Medicine and Radiation Biology, School of Medicine, University of California, Los Angeles.

A. Wallace is Associate Professor of Horticultural Science, University of California, Los Angeles.

The above progress report is based partly on Research Project No. 851.

BORER

Continued from page 10

gave a measure of control when treatments were spaced at monthly intervals.

The past four seasons' work on peach tree borer suggests that Thiodan, Endrin, or Dieldrin applied as trunk sprays will control the Western peach tree borer on apricots and, probably, on cherry, almond, peach, and prune.

When Thiodan, Endrin, or Dieldrin is used, extreme care must be taken to avoid contamination of fruit. Pump pressure must be reduced and a coarse spray nozzle used. Under no circumstances should a blower-spray be used. Hand spraying, with careful attention to confining the sprays to the tree trunk, offers the most readily controlled application.

What effect sprinkler irrigation may have on deposit of the toxicants is an important factor to be determined in further studies on trunk sprays to control the Western peach tree borer.

Harold F. Madsen is Associate Entomologist, University of California, Berkeley.

Ross R. Sanborn is Farm Advisor, University of California, Contra Costa County.

The above progress report is based on Research Project No. 806.

FRUIT HANDLING

Continued from page 4

ing from *L-3* to bins with a one mile haul would involve bin methods and savings of: at an output rate of 100 lugs per hour, use of Method *B-3* and an hourly savings of about $1.85; with an output rate of 200 lugs per hour, Method *B-1* and savings of about $4.00 per hour; with an output of 300 lugs per hour, it would be Method *B-2* and a savings of about $6.45 per hour.

The savings shown by the table are strictly applicable only when operating conditions, variable cost rates, equipment investment, and allocation rates are as specified. However, considerable changes in these factors would be possible without important shifts in the relative cost of the various methods.

Investment costs and carrying charges for containers depend on construction details, but run 35%–65% less per unit of fruit handled with bins than with lugs. When container and handling costs are combined, bins are the more economical container throughout the range of operating conditions considered in this study.

John F. Stollsteimer is Agricultural Economist, Agricultural Marketing Service, United States Department of Agriculture, and Associate in Agricultural Economics, University of California, Berkeley.

The foregoing article is based on a detailed report to be available from the Giannini Foundation for Agricultural Economics, 207 Giannini Hall, University of California, Berkeley 4.

MARKET STRUCTURE

Continued from page 2

has stayed relatively stable over the years, shifts among products are evident, and recent trends indicate a strong consumer preference for processed convenience foods.

Technological improvements developed to satisfy consumer preference for convenience foods emphasize the need for the fruit and vegetable canning industry to be progressive and dynamic—with new or improved processing techniques, cost-saving methods and specialized markets as in the cases of baby foods and dietetic products—to compete for consumer preference. Changes in marketing-sales-distribution organization and merchandising operations are being sought by some processors to strengthen their marketing position in the canning industry.

Industry Structure

A changing market structure confronts the canners of fruits and vegetables. The onetime prevalent independent wholesalers have been widely replaced by large scale organizations buying directly from canners for chain stores, voluntary cooperative buying groups, and wholesaler-retailer teams.

The competitive nature of the canners market is being restructured with altered bargaining relations. Some canners have turned to integration and merger and to improved and varied product lines as a means of meeting new and prospective market structure developments.

In efforts to protect and enhance their position, many growers have turned to cooperative bargaining associations and cooperative canning and to marketing order programs—under state enabling legislation—to regulate grade, size, quality and volume marketed and to increase demand through promotion and advertising.

From grower to retailer, the fruit and vegetable canning business has undergone significant changes and further change is in prospect. New and different market structures and institutions, technological developments, modifications in consumer attitudes and preferences require the canning fruit and vegetable industry to be alert and progressive to achieve further growth and development.

Market Demand

A current problem is the expanding farm output of fruits and vegetables for processing, because of increases in acreage and in yield.

Technological improvements in the canning industry seem able to meet the pressure of the increasing raw product supply while introducing increased cannery case-yield per ton for some products. But break-even production capacities and break-even product prices are being edged upward because of external developments. Canners and growers operate between supply pressure and cost pressure, and unit-cost reducing technology is needed by both growers and canners.

The demand for processing fruits and vegetables is directly related to the demand on canners—at the f.o.b. level—for the canned product. There is a strong tendency for the season average price of the canned product—for the marketing year, on an industry-wide basis—to be related to certain economic-marketing influences: the quantity of canned product sold; the level of national disposable income; and the level of prices of competing products. The interaction of these influences is highly significant in determining the industry-wide seasonal average f.o.b. prices received by canners.

The uptrend in national income has tended to raise the f.o.b. demand for

Concluded on next page