ing variety of lupine, identified as *Lupinus sellulus* was found. In the large pasture there was a larger lupine which has been identified as *Lupinus caudatus.* The privately owned pasture was large enough to hold 20 head of cows and the large pasture had enough area for the remainder of the herd.

Through the years the Ramelli herd has been on a rate-of-gain trial and each cow has been individually identified with a hot iron number on her loin. From this group of cows, 10 head of first-calf heifers and 10 head of second-calf heifers were randomly selected for the control group. This was done because it was felt this malady is more prevalent in the younger animals. However, in the remaining group of cattle there was another 10 head in each of these ages of heifers. The two groups were separated and the bulls turned in with the cows for breeding on May 25. These cattle went to the summer range on July 1, 1967, and were returned to the ranch September 30.

Inspection

Cows were inspected at regular intervals and feed samples were taken when the cattle first went on the range. In the July 28 inspection it was noted the cows were eating much of the lupine (*Lupinus caudatus*), in the large pasture while it was in the soft dough seed stage. The September 30 inspection showed they had eaten about two-thirds of the tops of the lupine plants. The feed and water samples taken at the beginning of the pasture season were run for heavy metals to see if these would be found in excess amounts. There were none to be found.

On November 11, the cows were pregnancy-tested and most were found between the four-to-six-month period of pregnancy. Cows were fed through the winter on meadow and alfalfa hay raised in Sierra Valley. They started calving on March 1st. On April 5, 1968, cows with crooked calves were identified. All cows having these calves were found to be from the group on the lupine (*Lupinus caudatus*) which had been believed to be causing the trouble (see table).

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HERBICIDES and sprinkler irrigation in vegetable crops

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DCPA

DCPA (Dacthal) is one of the very insoluble, low volatility, herbicides that can be activated by sprinkler irrigation following regular surface application. DCPA is particularly important to California onion growers. The herbicide apparently moves into the shallow root zone of germinating weed seeds. Surface applications of DCPA followed by sprinkler irrigation can cause injury to tomato, lettuce and melon seedlings, although incorporating DCPA mechanically for weed control in lettuce and peppers greatly reduced the phytotoxicity to these crops. Onions are more resistant to DCPA, however, and many summer weeds can be effectively controlled by surface application of DCPA followed by sprinkler irrigation, particularly in the deserts of southern California.

More research is needed to determine the exact amount of irrigation necessary to activate DCPA while allowing optimum safety to onions. In one test in the Antelope Valley, 2 acre-inches of water applied during the initial sprinkler set showed no detrimental effects. In another test on sandy soil in the Moreno Valley, 7 acre-inches applied during the first ten days was not excessive.

Diphenamid

Diphenamid (Enide or Dymid) is used for weed control principally in direct-seeded tomatoes and peppers in California. It has given more consistent weed control under sprinkler irrigation than incorporation by disking. Diphenamid has a solubility of 260 ppm in water, and is listed as non-volatile. Some recent controlled-irrigation experiments indicated that 2 acre-inches applied during the first irrigation may be more than desirable in one soil type (clay loam in San Benito). In another test on sandy soil at Moreno, 7 acre-inches of sprinkler-applied water was far in excess, severely damaging tomatoes direct-seeded at 2 to 8 pounds per acre. In two additional sprinkler trials on sandy soil, no injury to tomatoes was observed at 2 acre-inches and 2.4 acre-inches. High temperatures have been observed to increase the activity of diphenamid in Kern County. Since irrigation can reduce soil temperature, sprinkler irrigation may therefore modify the activity of diphenamid; although this has not been demonstrated experimentally in the field.

Trifluralin

Trifluralin (Treflan) is more easily activated by overhead sprinkler irrigation in freshly worked soil than on a hard surface as are some other low solubility herbicides. With a solubility of 0.5 ppm trifluralin has a relatively high volatility ($2.0 \times 10\text{-}4$ mm of Hg). Some loss will occur if sprinkler irrigation is not applied soon enough after the application of trifluralin. The critical interval is not known, but recent field data indicate that this period is greater than two hours on desert soils during the summer. Company labels suggest waiting no more than four hours to incorporate trifluralin.

A number of precision sprinkler irri-

With the increasing use of sprinkler irrigation on vegetables and other intensively grown crops, has come a need to evaluate herbicide effects. Herbicidal activity is often stepped up under sprinkler irrigation. The degree of crop selectivity may be increased, or decreased, depending upon the herbicide, the soil, the weed species, and the vegetable crop. Sprinkler irrigation advantages have been demonstrated, particularly in areas with saline soils or drainage problems. However, along with increased stands and vigor generally associated with sprinkling, comes an increase in weed populations. And as the cost of hand weeding rises, chemical herbicides become more desirable to the grower. The early use of sprinklers to help germinate the crop and activate the herbicide, even though furrow irrigation is used subsequently, is another promising approach in growing vegetables and other row crops. These observations of recent field tests and commercial applications of herbicides to control weeds under sprinkler irrigation are not to be considered recommendations for use of the herbicides mentioned. For recommendations, refer to University of California Weed Control Recommendations, 1969, or contact local farm advisors.

gation experiments indicate water applications up to, and including, 4 acre-inches do not reduce the weed control on selectivity of trifluralin on crops such as tomatoes and broccoli. Under sprinklers, surface-applied trifluralin must be used at about twice the usual application rate, but is safer on a greater range of crops. Persistence problems from the use of high rates of trifluralin are greatly reduced under sprinkler irrigation, probably because a smaller amount of trifluralin is incorporated into the soil than with mechanical incorporation. Considerably more work is necessary before specific recommendations can be made for trifluralin under sprinklers.

Nitralin

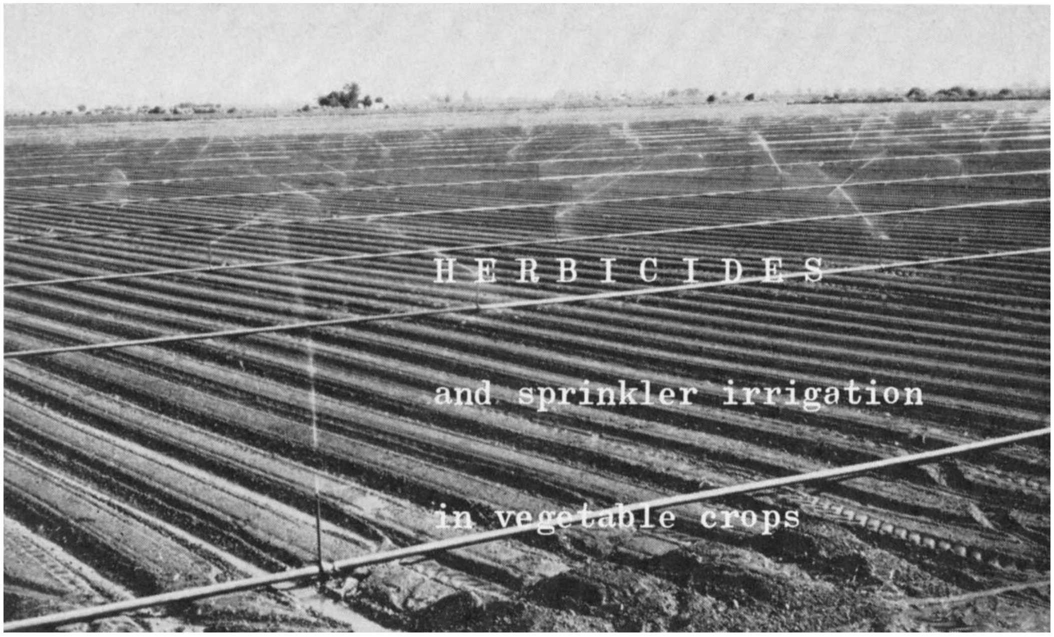
Nitralin (Planavin), like trifluralin, is quite insoluble but, unlike trifluralin, has

In studying effects of sprinkler irrigation on herbicidal activity, this precision irrigation test equipment was developed by University researchers (and manufactured by the Agricultural Manufacturing Co., Fresno) to allow accurate control of the amount and timing of precise amounts of overhead irrigation water.

PHYSICAL PROPERTIES OF SEVERAL IMPORTANT HERBICIDES ARBITRARILY DIVIDED AS TO LOW AND HIGH VAPOR PRESSURE

LOW			HIGH		
Herbicide	Water Solubility	Vapor* pressure	Herbicide	Water Solubility	Vapor* pressure
	ppm	mm Hg		ppm	mm Hg
Nitrofen	1.0	8.0 × 10-6	2,4-D	600	0.4
Diuron	42	3.1 × 10-6	Pyrazon	300	7.4 × 10-2
Nitralin	–	1.5 × 10-6	Pebulate	<30	6.8 × 10-2
Prometryne	48	1.0 × 10-6	Propachlor	700	3.0 × 10-2
Bensulide	25	1.0 × 10-6	EPTC	375	2.0 × 10-2
Picloram	430	6.2 × 10-7	Molinate	1000	8.8 × 10-3
Benefin	70	4.0 × 10-7	Dicamba	4500	3.8 × 10-3
Atrazine	33	3.0 × 10-7	CDEC	92	2.2 × 10-3
Propazine	9	2.9 × 10-8	Dichlobenil	18	5.5 × 10-4
Simazine	5	6.1 × 10-9	Trifluralin	<1	2.0 × 10-4

* Vapor pressure at temperatures closest to field conditions listed in technical literature.



a low volatility (1.5×10^{-6} mm of Hg). A number of sprinkler irrigation trials in light soils indicate that nitralin has excellent selectivity on freshly worked soil in a number of crops including onions, melon, broccoli, cabbage, asparagus and beans. It controlled most weeds well except for species of the mustard family. Persistence studies have shown that considerably more nitralin than trifluralin is incorporated into the shallow layers of soils by sprinkler irrigation—and that some residual activity can be expected from nitralin for several months. The optimum amount of initial irrigation for nitralin has not been determined. Irrigation from 2.6 to 7 acre-inches was adequate for activation of the chemical in a sandy soil low in organic matter. Some injury occurred on direct-seeded tomatoes and on cucumbers when nitralin was applied at 2 pounds per acre.

Benefin

Benefin (Balan) is moderately low in solubility and is low in volatility. Experiments have shown that benefin (chemically related to trifluralin and nitralin) gives good selective weed control in lettuce when surface-applied and sprinkled-in. The optimum amount of initial sprinkling has not been determined for benefin. Five acre-inches of sprinkling on a sandy loam did not result in maximum activity of benefin in one trial. No persistence problems have been observed after the use of high rates of benefin with sprinkler irrigation.

Bensulide

Bensulide (Prefar), also a low-solubility, low-volatility, herbicide (25 ppm solubility, vapor pressure 1×10^{-6} mm of Hg) has given erratic results under sprinkler irrigation. Very little information is available on the optimum amount of initial sprinkler irrigation for bensulide. Irrigation amounts from 2 to 7 acre-inches on sandy soils low in organic matter did not give adequate activation in three out of four trials. Erratic persistence problems have been observed from the use of bensulide under sprinkler irrigation. Sensitive crops have been injured long after bensulide application and mechanical incorporation; and, to a lesser extent, so have some sprinkler irrigated plots.

EPTC

EPTC (Eptam) is a moderately soluble (375 ppm), highly volatile (2.0×10^{-2} mm of Hg) herbicide. It controls a broad spectrum of weeds and performs well under sprinkler irrigation. EPTC was activated in a sandy soil low in organic matter, at irrigation rates of from one-half to 2 acre-inches. Application of EPTC through the sprinkler system is on the label for such crops as potatoes and beans. More work is needed with EPTC to determine optimum levels of irrigation and timing in different soil types, however. Repeated light irrigations after applications of incorporated EPTC on direct-seeded tomatoes and carrots have resulted in severe injury.

Prometryne

Prometryne (Caporal) is moderately low in solubility (48 ppm) and in volatility (1.0×10^{-6} mm of Hg). It is readily activated under sprinkler irrigation. The activity of prometryne and other triazines correlates directly with the amount of water applied. Severe toxicity has occurred from overirrigation of the triazines in commercial applications. General indications are that small increments of water, particularly with the initial irrigations, should be used with these herbicides. Prometryne is of particular interest to celery growers. More research is needed to determine the optimum irrigation levels, particularly for the initial irrigation.

Linuron

Linuron (Lorox), with a solubility of 75 ppm and a low volatility, does not require immediate irrigation. The optimum timing has not been determined, nor has the optimum level of initial irrigation. Like prometryne, the activity of linuron can be increased by irrigation. Linuron is of particular interest in the control of weeds in carrots. Great care is necessary in the use of linuron under sprinkler irrigation because severe injury has occurred in such crops as potatoes growing on sandy soils where irrigation has been heavy.

Nitrofen

Nitrofen (TOK), a relatively insoluble, low-volatility herbicide, is of considerable interest in the control of weeds in cole crops, carrots, celery and parsley. Some injury has been observed in the use of nitrofen under sprinkler irrigation on direct-seeded vegetable crops. Further research is necessary to establish the optimum level of irrigation for nitrofen. University recommendations only include pre-emergence use of nitrofen under furrow irrigation because of the lack of information on sprinkler irrigation. In the Imperial Valley, where rain is infrequent, nitrofen is used in furrow-irrigated sugar beets, but in other areas the frequency of rain prevents its use.

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