from October through December were weaned and weighed the latter half of June; those dropped from January through March were weaned and weighed in early October; and the April and May calves were weaned and weighed in early December. Fifty calves born from June through September were not reported as they represented only small numbers for each of the four months.

Calves received only their mothers' milk and the forage they grazed. Cows were not supplemented with either hay or concentrates except in a few short periods of extreme feed shortage.

There were no great differences in average daily gain and 205-day adjusted weight for calves born from October through March. Calves dropped in April and May had substantially lower daily gains and adjusted 205-day weights (table 1).

The 205-day adjusted weight and pre-weaning ADG are important for evaluating performance in beef cattle, but actual weaning weights are more important to the commercial cattleman. The cowman is selling actual pounds of calf and not adjusted weights. As a result the last 10 years of records (1956 through '65) were analyzed to check the effect of month of birth on actual weaning weight. The last 10 years of records were used because weaning times were relatively constant during this period. This period covered records of 1,373 calves dropped from October through May.

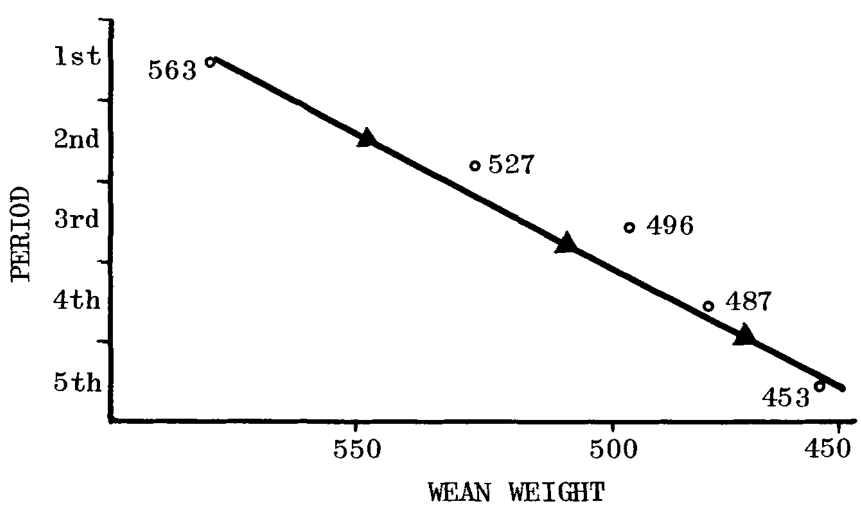
The study of actual weaning weights shows that the older calves in any weaning group are the heaviest, even though the ADG for some of the earlier calves was slightly less than for the later calves. Of the calves weaned in June, those dropped in October were 23 lbs heavier than November calves and 54 lbs heavier than December calves (table 2). Most October calves were dropped toward the end of the month, so they were not a full month older than the November calves. Most first calf heifers calved in October and November, and since they produce lighter calves, the increased average weaning weights for these months are even more significant.

Of the calves weaned in October, calves dropped in January and February had only 5 lbs difference in weaning weight. However, the January calves were 75 lbs heavier than March calves and 93 lbs heavier than early April calves (table 3). These differences are especially important because under this ranch operation it costs no more to produce an early calf than a late one. This may be equally true on most foothill and valley cow-calf ranches.

Analyzing records for the most recently completed weaning year (1968) on the same ranch again points out the value of calving as early in the season as possible. Records of 162 bull and heifer calves weaned in June showed that for each delay of 21 days in the calving period (average estrus cycle) weaning weight was reduced an average of 28 lbs (see graph).

There was a difference of 110 pounds in weaning weight between the first and fifth 21-day calving periods. For maximum weaning weights cattlemen should do everything possible to have all calves dropped early in the calving season. Greater returns from heavier calves could pay for extra feed and management expense that may be required on some ranches to insure earlier calving.

Walter H. Johnson is Farm Advisor, Shasta County; and J. T. Elings is Extension Animal Scientist, University of California.



Longidorus

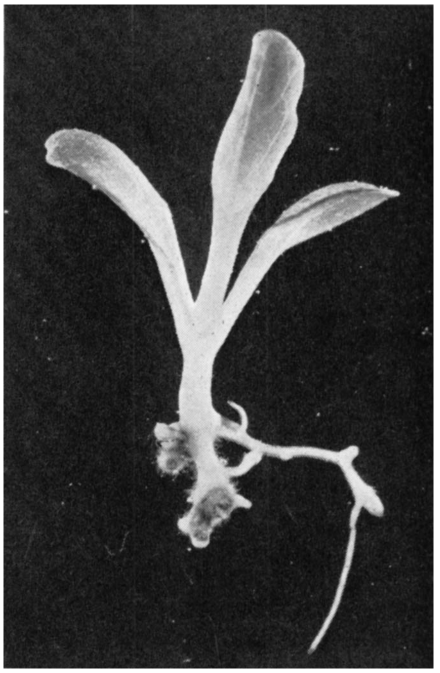
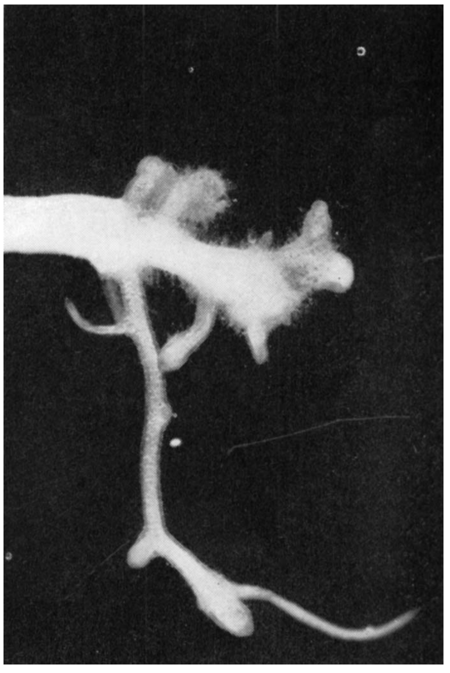


Photo 1. A typical diseased lettuce seedling from the field. Note swollen taproot tip.

Photo 1a. Close-up of diseased lettuce seedling illustrating lateral root damage.



africanus Merny . . .

NEMATODE FOUND PATHOGEN OF IMPERIAL LETTUCE

J. D. RADEWALD · J. W. OSGOOD · K. S. MAYBERRY · A. O. PAULUS
H. W. OTTO · F. SHIBUYA

In the fall of 1967, the nematode Longidorus africanus Merny was found in soil around the roots of stunted lettuce seedlings in the Imperial Valley of southern California. The seedlings appeared wilted and chlorotic and the tips of the tap roots were swollen and sometimes necrotic. Greenhouse experiments proved L. africanus to be a pathogen of head lettuce, and field samplings during 1968 showed the nematode was widespread throughout the valley. Many crops such as cotton, sorghum, alfalfa and sugar beets are hosts of this nematode. Preplant soil fumigation with 1,3-dichloropropene hastened crop maturity and significantly reduced tap root damage. The reasons this pathogen was only recently discovered are believed to be primarily: (1) the previous absence of surveys for nematode pathogens of head lettuce; (2) shorter fallow period between lettuce and the previous crop; (3) recent precision planting of the lettuce.

Head lettuce is the most important economic crop in the Imperial Valley. Approximately 40,000 acres of lettuce are grown annually, with a gross value of 40 million dollars. At the present time, lettuce is hand-harvested, a major expenditure in the overall cost of lettuce production. More uniform crop maturity is necessary before mechanical harvesting will be feasible. Lettuce head weight is also of economic importance especially during peak harvest periods when only premium lettuce is in demand.

Recent investigations conducted in the adjacent Palo Verde Valley have demonstrated that preplant soil fumigation has consistently increased mean head weights and has produced trends toward a more uniform crop maturity. In the fall of 1967 a lettuce grower called to the attention of the farm advisors an apparent seedling disease affecting some of his early fall-planted lettuce fields in the Imperial Valley.

Symptoms and distribution

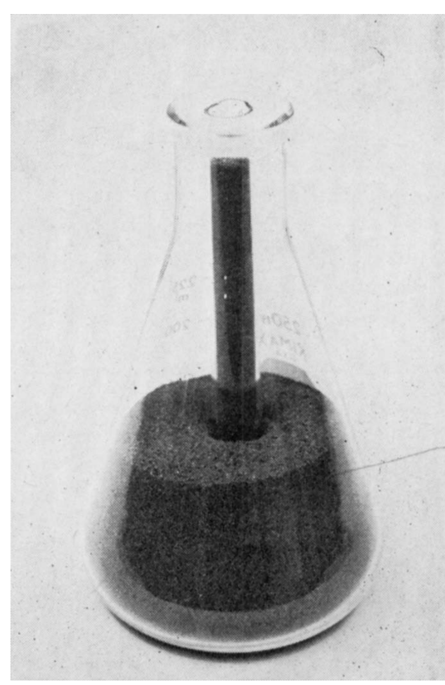
The disease was evident at the time of plant emergence in several of the grower's fields. The distribution of diseased seedlings was spotty in some fields and rather uniform in others. The cotyledon leaves of the stunted seedlings were cupped downward as if they were wilting, even though ample moisture was present for normal growth. These same leaves were a grayish green color and the outer margins were often chlorotic.

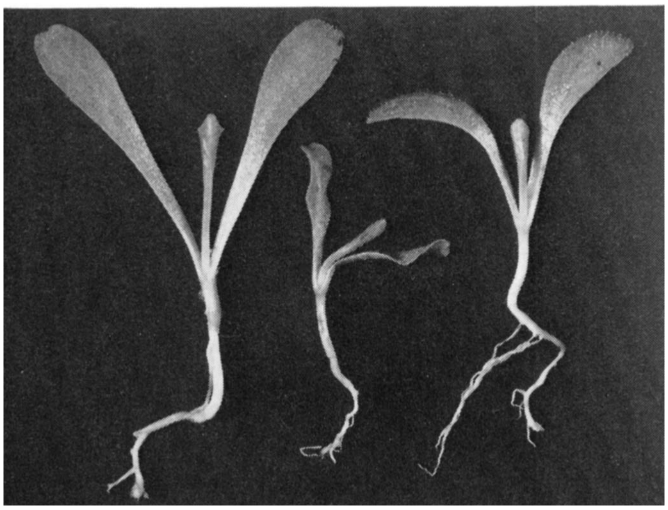
Tap roots of affected seedlings failed to elongate normally and were short with terminal swellings (photo 1). Necrotic areas on the swollen root tips were sometimes evident and it appeared that the meristematic tissues had been destroyed. Diseased plants frequently had compensated for the loss of the main tap root by lateral root proliferation; often these roots were similarly affected (photo 1a). In soil samples taken from areas where the disease symptoms were severe, *Longidorus africanus* Merny was found in high numbers. Few, if any, *L. africanus* were present in samples taken from areas where plants appeared healthy.

Soils from a fallow field, adjacent to the one where the disease was first found, were sampled and found to be infested with approximately 60 *L. africanus* per pint of soil. This field was scheduled to be planted with lettuce within a week. Therefore, a trial was initiated in this field to determine if preplant soil fumigation would control *L. africanus,* the suspected cause of this seedling disease. Concurrently, laboratory and greenhouse tests were conducted to determine the pathogenicity of *L. africanus* to head lettuce.

Soil from the field trial check plots was used as a source of *L. africanus* for the pathogenicity work. Nematodes were collected by the wet screening technique,

Photo 2. Inoculation tube within flask used for pathogenicity studies.





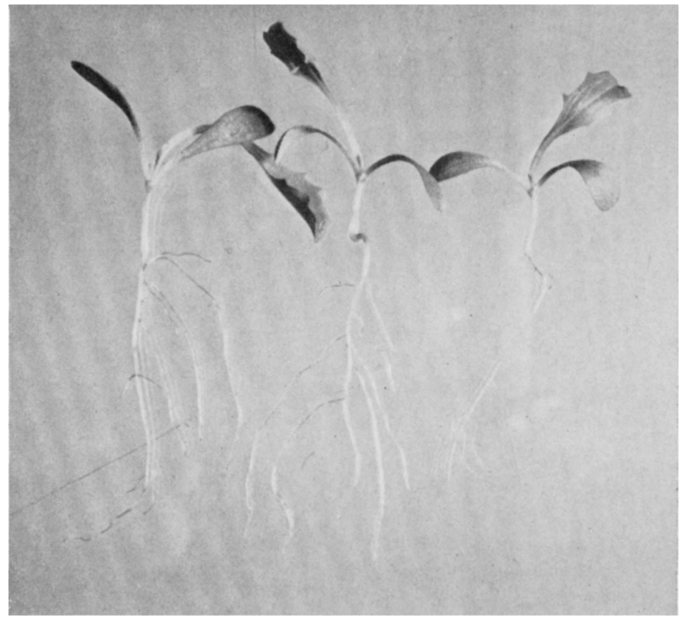


Photo 3 above). Plants grown in nematode infested soil. Photo 4 (right). Plants grown in noninfested soil.

with a 20-mesh screen to separate the coarse debris from the sample and a 150-mesh screen to retain the *L. africanus*. The nematodes were hand-picked from the 150-mesh screenings; washed repeatedly in distilled water and placed in the pasteurized soil (from the same valley fields) in inoculation tubes.

Inoculation chambers consisted of ½ inch-diameter glass tubing, three inches long. Known numbers of nematodes were placed in tubes half-filled with steamed soil. A single lettuce seed of the variety Great Lakes was then planted in each tube. Tubes were embedded in steamed soil in 500 ml Erlenmeyer flasks so that the top of the tube and the mouth of the flask were at approximately the same level (photo 2). The glass tubes were used as chambers within the flasks to concentrate the nematodes nearer the tap roots of the seedlings. Flasks containing the inoculated and the check tubes (same as above but without nematodes) were then placed in five temperature control tanks. Water temperatures were maintained at 55°, 65°, 75°, 85°, and 95°F. Records were kept on the date of emergence of plants from each of the four check and four treated flasks in each of the temperature tanks. Five to seven days after the plants emerged, the inoculation tubes were removed from the Erlenmeyer flasks, the plants were washed and root symptoms observed. Three trials were conducted in the manner described, varying the number of nematodes placed in each inoculation tube. In the three trials five, 20 and 50 adult females were used per tube.

Photos 3 and 4 illustrate typical results obtained in the pathogenicity trials. Under the experimental conditions, as few as five adult females of *L. africanus* per inoculation tube could produce the disease symptoms in young lettuce seedling roots. The root symptoms appeared identical to those observed under field conditions. Diseased and healthy roots from the pathogenicity trials, as well as those from the field, were preserved for anatomical study.

The disease was not evident in any experiment when temperatures were below 75°F, regardless of the nematode inoculum level. Further work is currently under way to more accurately define the minimum, maximum, and optimum temperatures at which the nematode can reproduce and cause this lettuce seedling disease.

TABLE 1. STATUS OF LETTUCE PLANT DEVELOPMENT FROM DATA COLLECTED BY SAMPLING 15 PLANTS FROM EACH TREATMENT IN EACH OF FOUR REPLICATIONS

Treatments	Mean weight of plants	Mean weight of tops	Mean weight of roots
	gms	gms	gms
Two weeks after planting			
14 gpa 1,3-D	1.66**	1.54**	.12**
Check	.58	.48	.06
Seven weeks after planting			
14 gpa 1,3-D	92**	86**	5.6**
Check	35	33	2.5

** Significant at the 1 per cent level.

Field control trial

The field selected for the fumigation trial was rotated out of sorghum two weeks before the fumigant was applied. The sorghum stubble had been disked, the field worked, sprinkler-irrigated, and four days later the beds for the lettuce were listed. Beds were formed on 40-inch centers.

Because of lack of time for proper aeration, only one fumigation treatment, 1,3-dichloropropene (DD or Telone) applied at 14 gallons per acre, was injected in the center of the bed with a single shank. Injection depth was 8 to 10 inches below the finished bed. A cultipacker was used to seal the shank marks. Plot size was four beds wide by ⅛ mile in length and the two treatments (14 gpa 1,3-D and the check) were replicated four times. Soil temperature at the point of injection was 75°F, and the moisture content was slightly above field capacity. The soil in this field was 69 per cent sand, 13 per cent silt and 18 per cent clay.

The beds were shaped and planted on precision hills (2 rows of lettuce, 12 inches apart with hills 11 to 12 inches apart in the row) four days after fumigation. Three to four seeds of the variety Climax were planted per hill. The lettuce was hand-thinned approximately three weeks after emergence. No fumigant toxicity was observed. Head weights were obtained by weighing the packed cartons from measured areas of the center two beds. Harvest crew personnel from the ranch did the harvesting and were not informed of the treatments. All plots were harvested three times.

Nematode counts were made by wet washing (with 20- and 150-mesh screens) randomly selected soil and plant samples from the two outside beds of the plots. (This was done to avoid loss of harvest information.) Counts were made by direct observations of the nematodes from the 150-mesh screenings.

Approximately two weeks after emergence, the plants in the fumigated plots

TABLE 2. DATA ON PLANT AND NEMATODE SAMPLINGS FROM THE LETTUCE-LONGIDORUS AFRICANUS FUMIGATION PLOT, IMPERIAL VALLEY, 1967–1968

Treatment	Date of root and nematode sampling	Samples where L. africanus was detectable	L. africanus found per sample	Plants sampled	Tap roots with terminal swelling	Roots forked at maturity
		%	mean no.	total no.	%	%
Check	11/3/67	100	219	289	71.0	
	11/13/67	100	181	806	89.0	
	12/29/67	71	4	**	**	
	2/27/68			10		80.0*
14 gpa 1, 3-D	11/ 3/67	40	36	238	2.0	
	11/13/67	25	50	742	3.0	
	12/29/67	17	1	**	**	
	2/27/68					10.0*

*Twenty-five root systems were examined from each of the two treatments of the four replications.
** No plant samples taken at this date.

TABLE 3. HARVEST DATA FROM THE L. AFRICANUS FUMIGATION PLOT, IMPERIAL VALLEY, 1967–68

Treatment	Heads harvested per replication	Mean hd. weight	Heads harvested
	Av. no.	lbs.	%
	First harveest 1/31/68		
14 gpa 1,3-D	343**	1.12	14.3
Check	42	.90	1.7
	Second harvest 2/12/68		
14 gpa 1,3-D	729**	1.84	30.4
Check	199	1.81	8.0
	Third harvest 2/27/68		
14 gpa 1,3-D	871	1.99	36.3
Check	1549**	1.95	64.3
Total			
14 gpa 1,3-D		7775	81.0
Check		7132	74.0

** Significant at the 1 per cent level.

were more than twice the size of those in the nonfumigated plots (photo 5 and table 1). Lettuce root samples were taken four times during the growing season. The first sampling was two weeks after planting; the second, seven weeks after planting; the third, nine weeks after planting, and the fourth at final harvest (tables 1 and 2).

The percentage of tap and lateral roots displaying the disease symptoms found in the first two samplings and the percentage of forked roots on mature plants are listed in table 2.

Nematode counts

Nematode counts were made three times during the course of this trial. The first two were made from soil collected with the plant root samplings described above; the third count was made from soil samples collected when the plants were approximately two months old. The effects of the fumigation treatment on nematode population levels at the three sampling dates are also presented in table 2. Wherever nematodes were found in either the fumigated or nonfumigated treatments, tap and lateral roots displayed gall symptoms. The lettuce was harvested three times and the results of the harvests are presented in table 3. Big Vein disease was present in the field and was evaluated when the plants were two months old and again at maturity. The severity of the disease was equal in both the fumigated and nonfumigated treatments.

Greenhouse pathogenicity

Greenhouse pathogenicity experiments and the results of the preplant fumigation trials have demonstrated that *L. africanus* is a pathogen of head lettuce in the Imperial Valley of Southern California. Controlled temperature work has initially indicated that only when soil temperatures are above 75°F will the nematode be of economic importance. This evidence is further supported by the low nematode population levels found in the last samplings of the field trial where average soil temperatures were below 70°F. The importance of *L. africanus* as an economic pest will depend in part on the planting date, and the soil temperatures during the growing season.

Twice growth

During the first two months of growth, plants in the fumigated plots were more than twice the size of the plants in the checks, and the fumigation treatment resulted in a much earlier plant maturity. Head size in the first harvest was small because of climatic conditions; however, the lettuce growing in the fumigated soil still produced heavier heads. Temperatures in the Valley during the last month of the growing season were abnormally high, allowing lettuce in the check plots to mature sufficiently for a third harvest. Under normal Valley growing conditions the total yields would have included only the first two harvests reported and the impact of preplant soil fumigation would be even more striking.

J. D. Radewald is Extension Nematologist; A. O. Paulus is Extension Plant Pathologist; and Fujio Shibuya is Laboratory Technician, University of California, Riverside. J. W. Osgood, K. S. Mayberry, and H. W. Otto are Farm Advisors, Imperial County.

Photo 5. Plots in front of and behind the farm advisor were fumigated. The four-bed plot in which he is positioned is a nonfumigated check.