PREPLANT SOIL FUMIGATION INCREASES HEAD WEIGHTS IN CALIFORNIA LETTUCE

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Preplant bed fumigation of lettuce soils significantly increased lettuce head weights in three Palo Verde field trials with DD and Telone. Treatments also produced trends toward more uniform and earlier crop maturity (although differences were not statistically significant). The reasons for the beneficial responses are not completely understood, but the responses were at least partly accounted for by the control of two nematodes, Tylenchorhynchus clarus and Meloidognye hapla.

THE USE OF soil fumigants as a means of controlling root knot and other plant parasitic nematodes has become an accepted grower practice in recent years for a number of susceptible annual crops in southern California, but little has been known of the importance of nematodes on head lettuce. The three tests reported here were part of trials conducted in nematode infested fields near the Colorado River in the Palo Verde Valley of southern California during 1966 and 1967. Information was also desired on the influence of soil fumigation on head size and on the uniformity of lettuce maturity—both essential for succcessful mechanical harvesting. The effectiveness of the fumigants as fungicides was also evaluated.

Fields chosen for the trials were known to be infested with one or several of the following nematodes: *Meloidogyne hapla, Tylenchorhynchus clarus, Pratylenchus scribneri, Helicotylenchus* sp., and *Trichodorus christiei.* One recent report on preplant soil fumigation indicated an increased yield and earlier maturity of lettuce resulting from the treatments; however the reasons for the beneficial responses were not indicated.

Trials were conducted in fields in which the previous rotation crop had been either sorghum or barley. The fumigants were applied at the time of listing with a single shank in the middle of the bed, or two shanks spaced 12 inches apart, each 6 inches off bed center (table 1). The fumigants were placed 10 to 12 inches below the level of the finished bed.

Spacing

Finished beds were 20 inches across the top and 6 inches above the level of the irrigation water (see photo). All beds were formed on 40-inch centers. Two rows of lettuce were planted 12 inches apart on each bed, from five to 10 days after fumigation. Seeds were spaced less than one inch apart in the row. After emergence, the lettuce was hand-thinned to a 12-inch stand within the row.

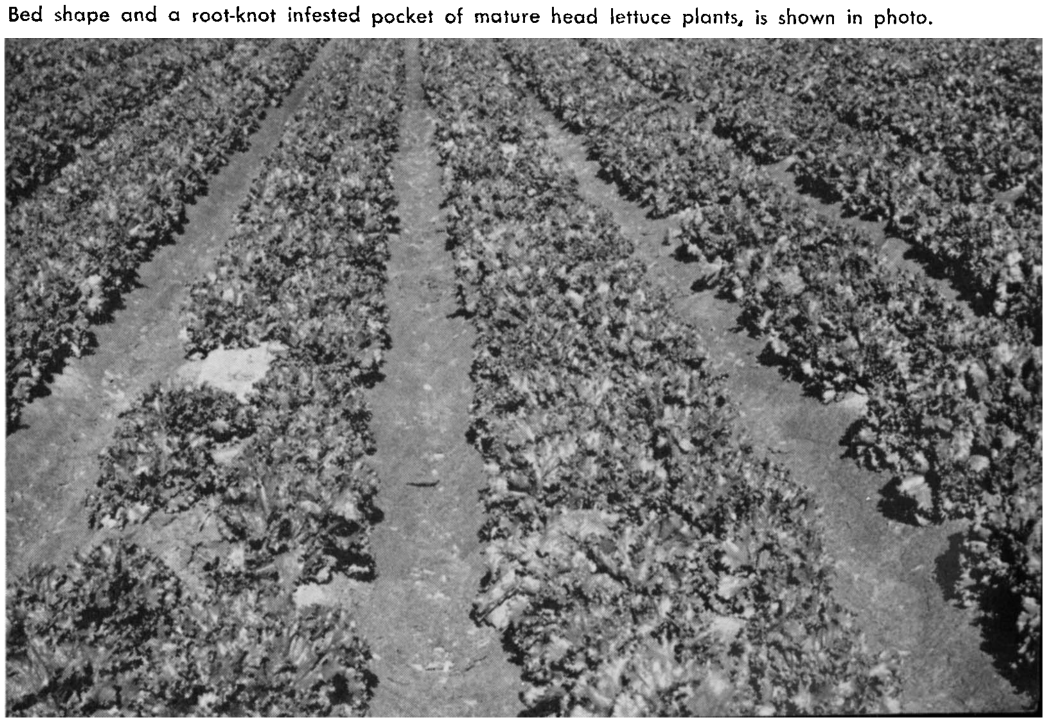
Nematode counts were made by wet screening (with a 20-325 mesh) a pint of soil taken from a composite of a minimum of 20 Oakfield soil cores per plot. Harvesting was done in a normal man-

TABLE 1. LETTUCE PREPLANT FUMIGATION DATA FOR TRIALS CONDUCTED IN THE PALO VERDE VALLEY OF CALIFORNIA DURING 1966 AND 1967.

Trial no.*	Lettuce variety	Crop rotation	Date of fumigation	Soil temperature at time of fumigation	Per-cent moisture	Soil type and mechanical analysis	Date of harvest
1	Great Lakes 659	Barley to Lettuce	9/2/66	89°F at 12 inch depth	8.9	Clay loam	11/29/66 12/ 9/66
2	Vangard	Sorghum to Lettuce	11/2/66	71°F at 12 inch depth	14.8	Sand 30% Silt 45% Clay 25%	3/20/67 3/27/67
3	Great Lakes 6659	Barley to Lettuce	8/30/67	90F° at 12 inch depth	—	Sand 57.6% Silt 16.2% Clay 26.2%	8/30/67

* Lineal feet of bed harvested per treatment was 200 feet in all three trials listed above; 2 rows per bed. Beds were 40 inches from center to center of furrows.

Bed shape and a root-knot infested pocket of mature head lettuce plants, is shown in photo.



Lettuce field, above, showing heads remaining after the second harvest. The major portion of these are severely infected with M. hapla. Note the remaining infected plants occur in small spots.

ner by ranch harvest crews who were unaware of the experimental treatments. Head weights of the lettuce were obtained by weighing packed cartons and calculating the average weight per head.

Soil temperatures, moisture contents, and mechanical analyses are presented in table 1 along with data on lettuce varieties, fumigation dates, and harvest dates. The 1,3-dichloropropene fumigants (DD and Telone) at 10, 15, and 20 gpa, applied in row, increased first-cutting head weights by as much as .3 pound (table 2). There were no significant differences between treatments in any of the three trials in number of heads packed, or percentage of heads harvested in either the first or the second cutting. The 15- and 20-gpa treatments appeared to produce earlier and more uniform maturation of the crop. These are trends, however, and are not statistically significant.

Nematodes involved

Soil samples for nematode identification were taken in the three fields prior to the time of fumigation, at least once during the growing season, and at harvest time. Root samples were observed from mature plants from two trials (1 and 3) and are illustrated here (opposite page). Note the proliferation of lateral and feeder roots in the fumigated plots as compared with the checks. *Tylenchorhynchus clarus*, a stunt nematode, was the only plant parasitic nematode that maintained itself or increased in numbers during trials 1 and 3. This nematode is not a proven pathogen of head lettuce and greenhouse trials conducted by the authors to date have failed to prove the pathogenicity of this species. Work is currently being carried out under controlled conditions to further evaluate the potential importance of this species to head lettuce.

In trial 2, a root knot nematode, *Meloidogyne hapla*, and a stubby root nematode, *Trichodorus christiei*, were the dominant species infesting the soil. Lettuce has been recorded as a host of at least two species of *Meloidogyne* in California. *Meloidogyne* species have not, however, been generally regarded as economically important pathogens of lettuce in the state. No information is available concerning the pathogenicity of *T. christiei* on head lettuce.

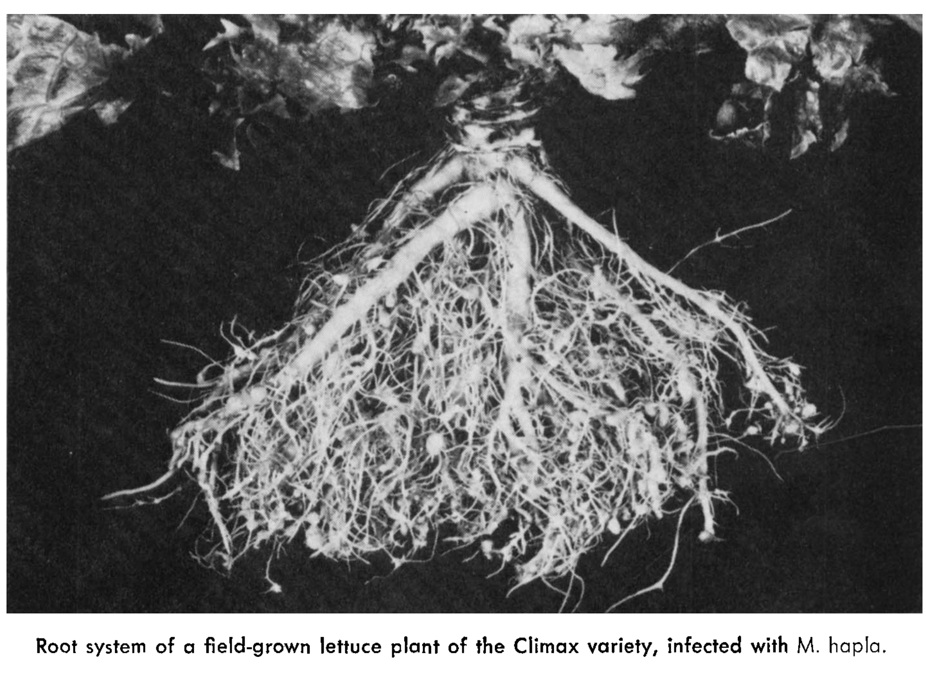
Increased head weights were obtained in all three trials. Why the beneficial response to the preplant in-row fumigation with the 1-3-dichloropropenes occurred in trials 1 and 3 is not known at this time, however, it is possible that one, two, or a combination of all three of the following factors were involved in the beneficial responses: 1) nematode control (*Tylenchorhynchus clarus, Meloidogyne hapla, Trichodorus christiei*), 2) influence of the fumigant on nitrification, 3) control of plant pathogenic fungi.

In these two trials, *T. clarus* did in-

TABLE 2. HARVEST DATA FROM THREE PREPLANT SOIL FUMIGATION TRIALS CONDUCTED IN THE PALO VERDE VALLEY OF CALIFORNIA DURING 1966–1967.

Trial no.	Treatments	Replications	Heads packed	Head weight	% Heads harvested
	FIRST CUTTING				
1	10 gal. 1,3-D	4	193	2.08 a	58
	20 gal. 1,3-D		210	2.16 a	61
	2.5 gal. EDB		196	1.95 b	54
	Check		188	1.99 b	57
			N.S.	*	N.S.
2	20 gal. 1,3-D	4	283	2.13 a	75
	20 gal. Telone-PBC		278	2.12 a	73
	Check		263	1.99 b	69
			N.S.	**	N.S.
3	15 gal. 1,3-D	6	251	2.2 a	81
	Check		242	1.9 b	77
			N.S.	*	N.S.
	SECOND CUTTING				
1	10 gal. 1,3-D		31	1.8	9
	20 gal. 1,3-D		30	1.8	9
	2.5 gal. EDB		33	1.9	9
	Check		40	1.7	12
			N.S.	N.S.	N.S.
2	20 gal. 1,3-D		11	—	3
	20 gal. Telone-PBC		1	—	0.2
	Check		24	—	6

* = Significant at the 1% level.
** = Significant above the 1% level.
N.S. = Not significant.

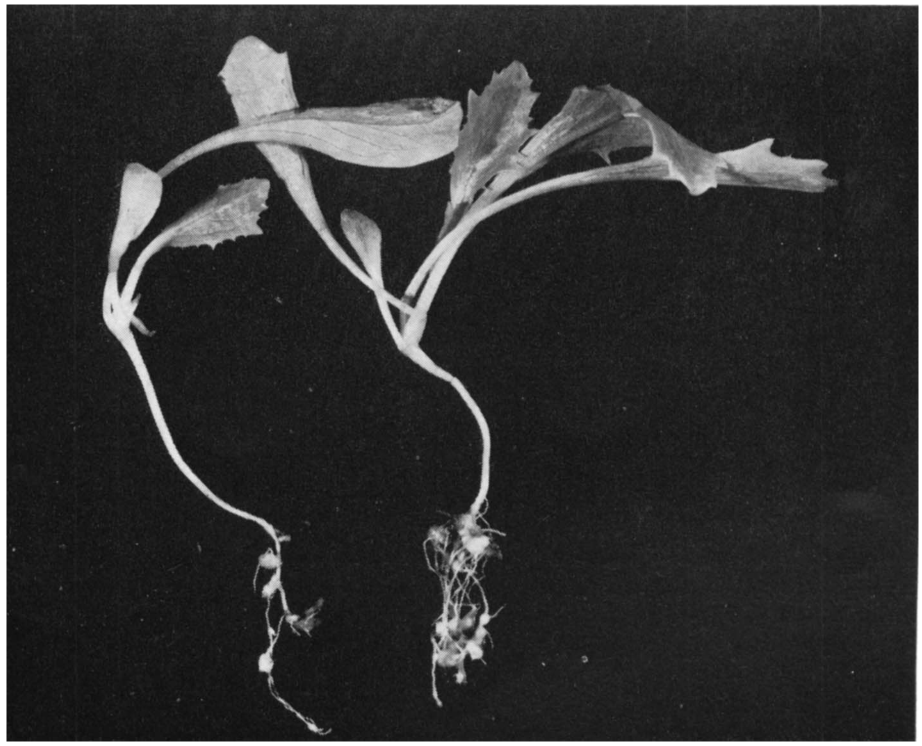


Root system of a field-grown lettuce plant of the Climax variety, infected with M. hapla.

crease to relatively high numbers and it is certain that they were utilizing the roots of the lettuce plants as a food source. Roots of the lettuce plants from these trials were examined for disease symptoms at the time the plants were mature. The only macroscopic difference in symptoms that could be detected between the check plants and those from the 20-gpa 1-3-D treatments was the obvious lack of lateral and feeder roots in the check plants (photo). No microscopic differences could be detected between the treatments. Similar differences were observed between the root systems of the 10-gpa treated plants and the checks; however, these differences were not as pronounced as those in the 20-gpa treatments. About the same level of the control of the stunt nematode, *T. clarus,* was obtained with the 10- and 20-gpa treatment application of 1-3-D.

In trial 2 there was a moderate population of second-stage larvae of the root knot nematode, *M. hapla,* present in the soil at the time of planting. It should be noted that since this trial was completed it has been determined that several sorghum varieties grown in this valley are hosts of *M. hapla,* and galling may or may not be evident on the root systems. The root knot nematode population level was stable during the first month of lettuce growth; the population, however, was not detectable at harvest. No root samples were taken from this trial at maturity. Shortly after this trial was completed, however, growers called to the attention of the farm advisor several lettuce fields which were extremely erratic in growth. Plants in spots of various sizes of fields were stunted, chlorotic, and never matured in time to be included in the normal harvests (photo). The heads remaining in the field after the *second* harvest had been completed are shown in photo 2. Roots of these late-maturing stunted plants were examined and found to be heavily infested with *M. hapla* (photo).

A survey was then made of 20 lettuce fields growing on coarse textured soils in the valley and 12 of them were found to be heavily infested with this nematode. It appears likely that the beneficial response to preplant fumigation in the one trial was at least partially due to the control of *M. hapla.* A preliminary pathogenicity test conducted with an *M. hapla* isolate taken from one of the infested fields has demonstrated its virulence on lettuce seedlings (photo). The root galling on these 14-day-old seedlings was produced by growing lettuce in soil containing approximately 600 larvae per pint. Preliminary observations indicate that the control of fungi or bacteria could not be the primary reason for the beneficial responses obtained from the application of the fumigant, however, further work is needed to prove or disprove this theory.



Fourteen-day-old lettuce seedlings shown were infected with M. hapla. Initial inoculum level was 600 larvae per pint of soil.

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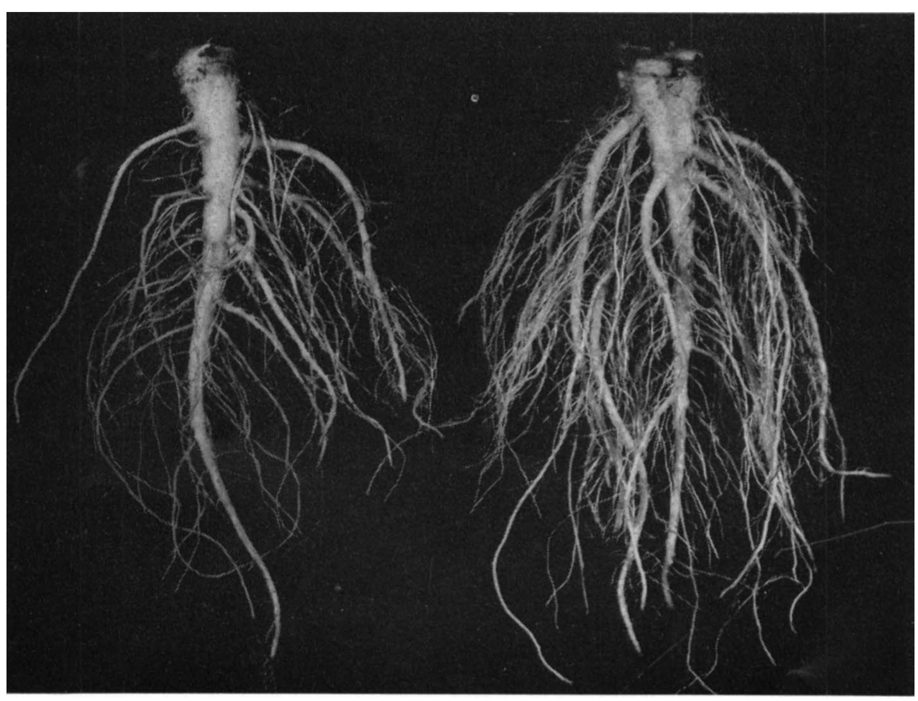
Cooperators in these trials included Fred Briggs and Bill Johnson of the Wilco Produce Co., and Robert R. Mecilizo of John Norton Farms.



Mature lettuce root systems photographed with check plant to left, and a plant from the preplant fumigant treatments (20 gpa 1,3-D) on the right.