

Table 1.—(continued)

| ADJUNCT OR STANDARD  | PER CENT                      |  | BARTHHRIN EQUIVALENT <sup>b</sup><br>(GEOMETRIC MEAN)<br>(MG. PER DL.) |
|--|-------------------------------|--|--|
|  | Knockdown<br>in 25<br>Minutes | Mortality<br>in 1 Day <sup>a</sup><br>(Arithmetic<br>Mean) |  |
| Allethrin,<br>214.1  | 100                           | 78.2   | —  |
| 142.8  | 100                           | 88.7   | —  |
| 95.17  | 100                           | 31.1   | —  |
| 63.45  | 99.9                          | 14.6   | —  |
| 42.30  | 98.6                          | 2.4  | —  |
| Required to demonstrate synergism<br>Equations and LC-50's for standards:<br>Barthrin, $Y = 5.4596X^{-0.1096}$ ; 894.1 mg. per dl.<br>Allethrin, $Y = 3.7257X^{-0.8581}$ ; 128.2 mg. per dl.<br>Relative standard error of mean barthrin equivalent, 9.35% | —                             | —  | 126  |

thrin or allethrin at half the concentration when they are applied by the same method.

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## The Effect of Soil Treatments of Chlordane or Heptachlor on the Flavor of Turnips, Parsnips, and Carrots<sup>1</sup>

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## ABSTRACT

Turnips, parsnips, and carrots grown in untreated soil or soil treated with 5 or 6 pounds per acre of heptachlor, or 5 or 10 pounds per acre of chlordane were evaluated for flavor. In one year an additional dosage of 20 pounds per acre of chlordane was applied to soil in which carrots were grown. Results of the palatability evaluations indicated that soil treatment with heptachlor or chlordane in the dosages reported had no adverse effect on the flavor of these three vegetables.

The application of chlordane or heptachlor has been employed in the growth of many food crops. It has been reported that applications of chlordane or heptachlor in the production of certain fruits and vegetables did not

adversely affect the flavor of peaches, raspberries, strawberries, beets, cabbage, carrots, cucumbers, radishes, rutabagas, squash, and turnips (Birdsall *et al.* 1957, Boswell 1955, Foster *et al.* 1956, Hard & Ross 1959, Stitt 1953). However, reports of other studies on the effects of chlordane (Birdsall *et al.* 1957, Boswell 1955) and heptachlor (Birdsall *et al.* 1957) indicate that off-flavors were found in carrots, lima beans, potatoes, pumpkin, sauerkraut, and tomatoes.

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This paper reports results of a study of palatability conducted in cooperation with the Entomology Research Division of the U. S. Department of Agriculture to establish more definitely whether the flavor of such underground crops as turnips, parsnips, and carrots was affected by soil treatment with heptachlor or chlordane.

**PROCEDURES.**—In 1956 turnips of the Purple Top White Globe variety and parsnips of the Hollow Crown variety were grown by the Entomology Research Division in plots located at Beltsville, Maryland. The two vegetables were grown in the same plots which were arranged in randomized blocks to provide four replications of the untreated and of each treated sample of both turnips and parsnips.

Dosages of 5 or 10 pounds per acre of chlordane or 3 or 6 pounds per acre of heptachlor were mixed with 5-10-5 fertilizer, applied to the soil at the rate of 1,000 pounds per acre, and disced in before planting time. The untreated control plots were fertilized only. Both crops were planted May 22, 1956; turnips were harvested November 8; parsnips, November 26.

In 1958 carrots evaluated were Germain's #48 Improved Long Type variety grown at Norwalk, California, by the Entomology Research Division Agricultural Experiment Station. Field plots were replicated twice for the untreated sample; however, only one plot was prepared for each of the treated samples. Chlordane and heptachlor treatments as used for turnips and parsnips were repeated with carrots. In addition, 20 pounds per acre of chlordane was included among the treatments to determine whether off-flavors would develop since it is possible that accidental over-dosage or accumulated dosages may reach this amount.

Carrots were planted April 10 after appropriate treatments were applied to the soil April 9. Plots were irrigated six times during the growing period with the irrigation water flowing from the untreated to the treated plots to avoid contamination of the control samples. Commercial 16-8-4 fertilizer was applied at the rate of 1,000 pounds per acre on May 16. Carrots were harvested July 7, 1958.

In 1959 a repetition of the experiment with carrots to provide replicated field plots was carried out in South Carolina. Carrots of the Chantenay variety were grown by the Entomology Research Division at their Agricultural Experiment Station in Charleston, South Carolina. Field plots were arranged in randomized blocks to provide four replications of the untreated sample and of each of the treated samples. Two dosages each of heptachlor or chlordane, the same as the previous year except for the elimination of the 20 pounds per acre chlordane dosage, were applied in the form of an emulsion in 50 gallons of water per acre. The insecticide and fertilizer were mixed into the soil to a depth of 4 to 6 inches with one trip of a double disc harrow. Carrots were seeded January 22, 1959, and harvested May 8.

As soon as possible after harvest the vegetables were delivered to the Human Nutrition Research Division laboratory. Turnips were held at 32° F. from the date of delivery for about 3 weeks during the course of the taste tests. Parsnips were stored at 32° F. for 2 months to allow for the development of sugar and characteristic sweet taste before palatability evaluations were con-

ducted. Harvested carrots of the 1958 crop were stored 1 week and those of the 1959 crop for 3 days at 32° F. before the taste tests were started. Carrots of both the 1958 and the 1959 crop were held at 40° F. for approximately 2 weeks during the course of the palatability evaluations.

All vegetables were removed from cold storage and warmed to room temperature (70° F.) before preparation. Each sample was scrubbed, rinsed in distilled water, and dried. It was then pared and cut into the desired size for cooking; turnips were cut into  $\frac{1}{2}$ -inch cubes, parsnips sliced crosswise, and carrots cut into  $\frac{1}{2}$ -inch dice. Carrots were also served raw as strips. The cleaned carrots were cut into top and bottom halves and put into two lots. These halves were cut lengthwise into  $\frac{1}{2}$ -inch strips and chilled 10 minutes in a refrigerator until tested by the panel.

Each sample of a specific vegetable was cooked in a covered enamel pan in a minimum amount of boiling distilled water for a predetermined period; 18 minutes for turnips, 15 minutes for parsnips, 18 minutes for 1958 carrots, and 10 minutes for 1959 carrots. Carrots cooked in 1959 were less mature and thus more tender than those cooked in 1958. Drained cooked turnips were then mashed with a potato masher and stirred to make a homogeneous sample. Parsnips and carrots were drained and served to the panel members without further preparation. For each sample of raw carrots two strips from the top halves and two from the bottom halves were randomly selected to insure the tasting of all portions of the carrots by each panel member.

Palatability evaluations were made by five members of the Human Nutrition Research Division staff in a room separate from that in which the samples were prepared. The panel members were not connected with the preparation in any way. Individual portions of each raw and cooked vegetable sample were served in coded white dishes to the panel members at 5-minute intervals. Evaluations were made at individual tables so arranged that panel members could not observe each other's reactions.

Flavor was evaluated on 5-point scales on which 5 represented natural, no off-flavor; 4, slight off-flavor; 3, moderate off-flavor; 2, strong off-flavor; 1, very strong off-flavor. Similar scales were used in evaluating odor of turnips and parsnips.

The experimental design used in the palatability evaluations of turnips, parsnips, and 1959 carrots was a Youden square (Cochran & Cox 1957) which consisted of five sessions at each of which four different samples were served. The design provided four replications for each of the five treatments, each replication corresponding to a field block. Another Youden square design was used for the serving order of 1958 carrots in which two replicated lots of the control sample provided for the seven treatments required for this design. Samples of four treatments were served at each of seven sessions. The design yielded eight scores for the untreated sample and four for each treated sample. Raw and cooked carrots were evaluated in separate experiments.

**RESULTS AND DISCUSSION.**—Flavor and odor scores for cooked turnips, cooked parsnips, and raw and cooked carrots are presented in table 1.

Each mean score for flavor of turnips or parsnips

Table 1.—  
with heptachlor

| TREATMENT  | Test difference |
|------------|-----------------|
| Untreated  |                 |
| Heptachlor |                 |
| Chlordane  |                 |

<sup>a</sup> Means for un-  
<sup>b</sup> Score of 5 re-  
<sup>c</sup> Score of 3 rep-  
<sup>d</sup> The differenc-

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Table 1.—Mean odor and flavor scores<sup>a</sup> for turnips, parsnips, and carrots grown in untreated plots and in plots treated with heptachlor or chlordane.

| TREATMENT                    | DOSAGE<br>(LB./<br>A.) | CARROTS           |                     |          |        |            |         |               |         |
|------------------------------|------------------------|-------------------|---------------------|----------|--------|------------|---------|---------------|---------|
|                              |                        | TURNIPS           |                     | PARSNIPS |        | Flavor—Raw |         | Flavor—Cooked |         |
|                              |                        | Odor <sup>b</sup> | Flavor <sup>c</sup> | Odor     | Flavor | Calif.     | S. Car. | Calif.        | S. Car. |
| Untreated                    | 0                      | 4.9               | 4.2                 | 4.8      | 4.4    | 3.5        | 4.0     | 3.2           | 4.2     |
| Heptachlor                   | 3                      | 4.8               | 4.6                 | 4.8      | 4.8    | 3.8        | 3.6     | 4.0           | 4.4     |
|                              | 6                      | 4.8               | 4.4                 | 4.8      | 4.4    | 4.0        | 4.2     | 3.1           | 4.4     |
| Chlordane                    | 5                      | 4.8               | 4.5                 | 4.8      | 4.0    | 4.5        | 3.7     | 3.8           | 4.6     |
|                              | 10                     | 4.6               | 4.5                 | 4.8      | 4.3    | 3.7        | 3.9     | 3.8           | 4.1     |
|                              | 20                     | —                 | —                   | —        | —      | 4.0        | —       | 3.9           | —       |
| Test difference <sup>d</sup> |                        | 0.4               | 0.5                 | 0.6      | 0.7    | 1.2        | 1.0     | 0.6           | 1.0     |

<sup>a</sup> Means for untreated carrots, 1958, were based on 46 scores (11 scores for each of 5 judges); other means were based on 60 scores (4 scores for each of 5 judges).

<sup>b</sup> Score of 5 represents natural, no off-odor; 1, very strong off-odor.

<sup>c</sup> Score of 5 represents natural, no off-flavor; 1, very strong off-flavor.

<sup>d</sup> The difference between two means is significant at the 5% level when it equals or exceeds the test difference (Duncan & Bonser test 1964).

grown in soil treated with heptachlor or chlordane was not significantly different from the mean flavor score for the untreated sample indicating that off-flavors did not develop. Mean scores for odor of turnips and parsnips were higher in all instances than those for flavor and no off-odors were found. All scores for these two vegetables were 4.0 or above indicating the presence of only slight off-odor or off-flavor in some samples.

In both years, 1958 and 1959, the mean score for flavor of raw carrots grown in untreated plots was not significantly different from any of the mean scores for flavor of samples grown in soil treated with heptachlor or chlordane.

In the 1958 evaluation of cooked carrots each of the mean flavor scores for samples from treated plots was significantly higher than the mean score for flavor of carrots from untreated plots. In 1959, however, cooked carrots prepared from samples grown in treated plots received a mean score for flavor which was not significantly different from any of the mean flavor scores received by the carrots grown in untreated plots.

No effect on flavor of carrots either raw or cooked was indicated by soil treatment of chlordane at 20 pounds per acre.

The flavor of turnips, parsnips, and carrots was not adversely affected when any of these vegetables were

grown in soil treated with 2 levels of heptachlor or 2 or 3 levels of chlordane.

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