"Reprinted from January 1980 issue of 'Indian Farming'"

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BURROWING NEMATODE A POTENTIAL THREAT TO AGRICULTURE

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THE burrowing nematode, *Radopholus similis* occupies the second position only to the root-knot nematode among the economically important plant parasitic nematodes in the tropical and sub-tropical regions. The nematode is notorious as the cause of spreading decline of citrus in Florida, Pepper yellows in the Bangka island of Indonesia and root and rhizome rot of banana in all banana growing tracts of the world except in Israel and Taiwan. In India the nematode was first recorded only in 1966 from banana roots in Kerala. Recent surveys have shown its widespread occurrence in Kerala, Karnataka and Tamil Nadu on coconut, arecanut, banana and pepper. *R. similis* may be indigenous to Kerala as various varieties of banana are known to be cultivated here since long. The possibility of its introduction along with the cavendish type of banana also cannot be ruled out. The nematode was first described by Nathan Augustus Cobb from banana roots from Fiji in 1893 as *Tylenchus similis*. Subsequently the nematode was roported causing extensive root lesions and cavities in the roots of coffee in Java and in sugarcane in Hawaii. *Radopholus* is considered to be indigenous to Australia and New Zealand because nine of the eleven species of the genus are found in these areas.

Significance

The nematode is known to parasitize more than 250 species of plants throughout the tropical and sub-tropical regions which makes *R. similis* the most significant pest of agricultural crops. Parasitization by this nematode causes gross reduction in the quality and quantity of yield. It has wiped out over 20 million pepper vines of Bangka Island over a short period of two decades. More than 15 thousand acres of citrus in Florida are reported to be infested with *R. similis*. Reduction in yield from 50 to 80 per cent for grape fruit and from 40 to 70 per cent for oranges are reported. At an average fruit value of £2/box the grower incurs a loss of $19,549/ha. In Surinam, where there was 100 per cent infestation on banana, the yield was 37 tons/ha/year but when the infestation was less, the yield was 73 tons/ha/year.

In India no data is available on loss due to *R. similis* infestation on any crop, though the nematode was recorded in 1966 and known to parasitize several crops such as black pepper, cardamom, ginger, turmeric, sweet potato, sugarcane, groundnut, coconut, arecanut and banana and has also been reported in association with diseases such as slow wilt of pepper, coconut root (wilt) and arecanut yellow leaf.

Dissemination. The nematode is disseminated mainly through infested planting materials, floods, irrigation water, farm implements and bulk transport of soil. The nematode is known to spread in Florida downhill at the rate of 66 metres and uphill at the rate of less than 8 metres within a year.

Morphology and Biology

The nematode is known for its sexual dimorphism. The female nematodes vary in length from 0.520 to 0.880 (0.690) mm, with an average width of 25.6 μ and a spear of about 18 μ with well developed basal knobs. Males vary in length from 0.590 to 0.670 (630) mm with degenerated oesophagus and spear and an elevated non-striated lip region.

R. similis is a migratory endoparasite, capable of a soil phase in adverse conditions. The life cycle is completed in 20-2[illegible] days at 24-32°C. Egg, four larval and an adult stage are the different phases in its life history. All larval stages and females are infective. Fertilization is usual but parthenogenesis does occur. The nematode has two biotypes having no morphological differences (1) the 'banana race' attacking banana but not citrus, and (2) the 'citrus race' pathogenic to both banana and citrus. The 'citrus race' is at present confined to Florida and has a wide host range compared to the 'banana race.' The coconut, arecanut and banana populations in Kerala have been identified as the 'banana race' and the coconut population is known to have a host range of over 41 species of plants. The host range of other populations has not been studied so far and the existence of other biotypes is very likely. The host range and race status of the black pepper population in Kerala and Karnataka needs immediate attention.

Studies on annual periodicity of *R. similis* populations in coconut and arecanut root revealed that the maximum population occurs during September to November and minimum during March to June. Hence, it is preferable to conduct regular surveys for detection during the peak season.

Symptoms

The most obvious symptoms of attack on banana is the toppling of plants especially those at the bearing stage. Other symptoms include lack of vigour, premature defoliation and reduction in bunch weight, size and number of leaves. In citrus, the declining trees have fewer and smaller leaves and more dead twigs than healthy trees with a tendency to wilt. The new growth flushes are weak, fruit set sparse and yields low, but death is not usual. In both banana and citrus *R. similis* occupies an intercellular position in the cortical parenchyma where they feed on the cytoplasm of nearby cells, destroying them and causing cavities to develop. These cavities coalesce and are continually enlarged by the nematode's feeding and tunnelling laterally and towards the endodermis, producing the characteristic reddish brown lesions in the cortex. When extensive cavities have formed, cracks with raised margins appear on the root surface. Nematodes enter the stele in citrus via endodermal passage cells and accumulate in the phloem and cambium secondary invasions of the lesions by other fungal organisms causes necrosis.

The first indication of slow wilt disease in pepper is the appearance of occasional yellowed leaves, which increase in number until within a year large portion, or even all, of the foliage my become involved. The growth is arrested and production of panicles rapidly declines. Severe die-back and death of the plants eventually follow. The young, fleshy feeder roots show lesions and develop extensive necrosis.

In coconut roots, *R. similis* produce small, elongate, reddish brown lesions which later coalesce and cause extensive root rotting and reduce lateral root production The nematode population is found confined [illegible]stly to the cortical region of the root. The affected [illegible] exhibits considerable reduction in growth and vigour. Apart from these blackening of the root t[illegible] was another common symptom in arecanut.

Association with fungi. Incidence of panama w[illegible] of banana caused by *Fusarium oxysporum* f. *cubense* g[illegible] doubled in Gros Michel banana when *R. similis* is add[illegible] to the soil and wilt symptoms appeared faster on [illegible] *similis* infected bananas as the fungus alone is unal[illegible] to invade intact banana roots. The spreading decli[illegible] of citrus also involves an interaction of *R. similis* wi[illegible] *Fusarium, Sclerotium* and other soil inhabiting organism[illegible] The fungus *Cylindrocarpon musae* is found constant[illegible] associated with *R. similis* in banana. Recently *Cyli[illegible] drocarpon effusum* and *C. lucidum* have been isolated fro[illegible] lesions caused by *R. similis* on coconut roots.

Control

Paring banana sets involving removal of all d[illegible] oured portions, followed by a dip in Bordeaux mix[illegible] and DBCP paste, the infection gets reduced from [illegible] per cent to 1 per cent after 8 months. Hot water trea[illegible] ment of banana sets at 55°C for 20 minutes is [illegible] standard practice in Central America and Australi[illegible] Flood fallowing is practised successfully in Surinam[illegible]

In Florida, push and treat method (DD at 100 gallon[illegible] acre) is practised for eradicating the burrowing nema[illegible] tode from commercial groves and with chemically trea[illegible] ted buffers (EDB at 50 gallons/acre). To prevent th[illegible] burrowing nematode from becoming established i[illegible] healthy groves, bare-rooted citrus plants treated wit[illegible] hot water at 122°F for 10 minutes are planted.

The common coconut cultivars West Coast Tal[illegible] Dwarf Orange, Dwarf Green, Gangabondam, Laccadiv[illegible] Ordinary, Tall × Dwarf, Dwarf × Tall, and Tall [illegible] Gangabondam were found susceptible to *R. similis* o[illegible] inoculation. Thirty-one Areca germplasm collec[illegible]ions available at CPCRI, Vittal were screened again[illegible] the arecanut population of *R. similis* and all of the[illegible] were found susceptible.

To release burrowing nematode-free coconut seed[illegible]lings from heavily infested nurseries in Kerala a di[illegible] treatment in 1000 ppm DBCP for 15 minutes was foun[illegible] effective and is recommended.

In India the nematode is at present known to exis[illegible] only in Kerala, Karnataka and Tamil Nadu states. Re[illegible]cently the nematode was reported from a geographicall[illegible] isolated area like Lakshadweep also which might hav[illegible] been introduced through the several shipments of banan[illegible] suckers from Kerala and Tamil Nadu to these islands[illegible] This brings out the necessity for an intensive survey o[illegible] areas growing banana, coconut, pepper and othe[illegible] known hosts of the nematode at the earliest and adop[illegible]tion of strict quarantine measures against the movemen[illegible] of planting material from infested to non-infested areas especially so in view of its wide host range, very hig[illegible] potential as a pathogen, association with other microor[illegible]ganisms as an incitant in complex diseases and thei[illegible] possible involvement in diseases of national impor[illegible]

Agri. Res. J. Kerala, 1972, 10 (2)

ON THE OCCURANCE OF PLANT PARASITIC NEMATODES ASSOCIATED WITH DIFFERENT CROPS IN CANNANORE DISTRICT, KERALA

The information available on the prevalence and distribution of injurious forms of plant parasitic nematodes associated with various economically cultivated plants in our country, especially in Kerala, is still fragementary. Sitharamaiah *et. al.* (1971) has compiled and published a list of plant parasitic and soil nematodes reported from India with a host nematode index. Though references are available in this publication on the prevalence of plant nematodes associated with various crops in Kerala it does not cover any report pertaining to Cannanore District.

A survey was conducted and the plant parasitic nematodes observed from various locations in this District are reported here.

Table 1

Distribution of plant parasitic nematodes in different locations in Cannanore District

Locations	No. of Soil Samples/plants examined	Host crop (Plant)	Parasitic Nematodes encountered
Central Coconut Research Station, Nileshwar	3/from fields	Coconut intercropped with vegetables	2,3,5,6,7,9
,,	1/ornamental garden	*Alternanthere versicolar* - Regel Amaranthacene	2
,,	1/Fields	Banana	4
Periya (Kanhangad)	1/Plants from cultivators fields	Tobacco (Local variety)	1
Chullipalla Manakaday Rayoram	3/cultivators fields	Black pepper (*Piper nigrum*)	2,4,5,7,8,10
Muringody (Peravoor)	2/ ,,	,,	4,5,7,10,11

Note.

1. *Meloidogyne javanica*
2. *Meloidogyne incognita*
3. *Hoplocimus indicus*
4. *Radopholus similis*
5. *Rotylenchulus reniformis*
6. *Praty lenchus*
7. *Helicotylenchus sp.*
8. *Hoplolaimus sp.*
9. *Crieonemo'des sp.*
10. *Hemicycliophora sp*
11. *Heterodera larvae*

It is evident from the above survey that *Radopholus similis* is widely prevalent in gardens where pepper vines are cultivated and is suspected to be associated with the slow wilt disease of the crop.

The author is thankful to Dr. B. K. Nair, Head, Botany Department, University of Calicut for indentification of the plants and to the Head, Nematology Division, I. A. R. I., New Delhi, for indentification of the nematodes. The encouragements and facilities provided for the above studies by the Dy. Director (Coconut Research) C. C. R. S. Nileshwar is gratefully acknowledged.

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(*MS. received*: 26-2-1973)

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OCCURRENCE OF HETERODERA MOTHI, A CYST NEMATODE, IN THE UNITED STATES

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Cooperative investigations of ARS, USDA, and the University of Georgia College of Agriculture Experiment Stations, Coastal Plain Station, Tifton. Plant Dis. Reptr. 57: 946.

In 1965, Khan and Husain (2) described a cyst nematode (Heterodera mothi) from the roots of nutsedge (Cyperus rotundus), on the campus of Aligarh Muslim University, Aligarh, India. There appear to be no further published reports by other authors on this species, except of a taxonomic nature, to compare related species.

In June 1972, we recovered larvae and cysts of Heterodera from soil samples from soybean (Glycine max) experimental plots on the Southeast Georgia Branch Experiment Station, Midville, Georgia. In August of the same year we found cysts on roots of yellow nutsedge (Cyperus esculentus) growing in these soybean plots and in cotton (Gossypium hirsutum) plots several hundred yards away. Cysts were not found on roots of soybean, cotton, and crabgrass (Digitaria sp.) growing in the area. Initially this nematode was thought to be an undescribed form, although in several respects it was similar to H. cyperi Golden, Rau & Cobb, 1962 (1), described by them from yellow nutsedge, C. esculentus, in Florida. Further study, including examination of H. mothi specimens from India obtained from Dr. Alan Stone of Rothamsted Experimental Station in England and Mr. Roland Mulvey of Canada Department of Agriculture in Ottawa, however, showed this cyst nematode from Georgia to be H. mothi.

This is the first known occurrence of this cyst nematode in the United States. It is widespread in the field at Midville. This nematode is not known to be parasitic on hosts of economic importance. We are investigating its possible host range and biology, however, especially in relation to corn, small grains, and other economic grass crops.

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YIELDS AND FLAVOR OF POTATOES AND CARROTS ON PLOTS RECEIVING ANNUAL SOIL TREATMENTS

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Summary

Nine chemicals were applied to replicated plots to determine their influence on yields and flavor of potatoes and carrots. A single dosage equivalent to that applied in 10 years was made for each material at the start of the experiment. Annual rates were applied to other plots at yearly intervals for 3 years. No annual dosage of any chemical resulted in a significant reduction in yield. Both crops were significantly reduced on plots receiving one application of 5000 pounds of D-D, Dowfume N, and dichlorobutenes. This reduction persisted for 1 year. Off-flavor was detected only in the 5000-pound rate for D-D and Dowfume N after 1 year, but not after 2 years.

With the amendment in 1959 to include nematocides under the Federal Insecticide, Fungicide, and Rodenticide Act, the need for data on residues, including any causing changes in flavor, becomes urgent. It seems desirable, therefore, to report data obtained from experiments conducted beginning in 1949. The purpose of these tests was to study the relation between the persistence in soil of nematocides and the yields and edible qualities of potatoes and carrots grown in soil previously treated with these chemicals.

The experiment was located at the Long Island Vegetable Research Farm, Riverhead. The taste tests were run at Ithaca with the cooperation of Dr. Alice M. Briant of the Department of Food and Nutrition, College of Home Economics.

In April 1949, an area classified as Sassafras silt loam 200 by 204 feet was divided into strips 20 feet wide. The proposed test crops were planted in each strip to index the experimental area as to productivity and any fungus or nematode infestations present. Two rows of potatoes (Katahdin) were planted in April. In July, three rows of carrots (Nautis) were sowed and three rows of cauliflower (Efurt) were set in each plot. Records were made of all fertilizer and spray applications to the plots. In September each strip was divided into plots 17 feet long. The potatoes were dug and yields per plot determined. Note also was made of amounts of scab, Rhizoctonia and wire worm injury. The cauliflower plants were dug and the roots scored for club-root infection. The carrots were dug and roots scored for degree of root-knot nematode damage and total yields per plot determined.

After indexing, the entire area was prepared for treatment by discing in two directions. Three replicates of treatments involving nine chemicals (Table 1) were applied to plots 17 x 20 feet. All liquids were injected 6 inches deep on 10-inch staggered centers by means of handguns. The dry materials were spread on the surface and raked into the soil. An attempt was made to include all chemicals recommended for application to the soil at the time the experiment was begun in addition to some of the newer materials which might be adopted later. Where a fumigant[3] contained more than one chemical, an attempt was made to include individual components as separate treatments. The dosages employed included at least one yearly recommended dosage and an amount normally applied in 10 years which was to be applied only once, in the fall of 1949. Three weeks after treatment, a cover crop of Ambruzzi rye was sowed in all plots. All annual applications were repeated in the fall of 1950 but only eight were selected, on the basis of the 2 previous years' experience, for application in 1951.

The same crops were planted each spring on the approximate dates utilized to index the experimental area. In the fall of each year, usually September, the carrots and potatoes were dug and yields recorded. Prior to taking yields, plants in 1 foot at each end of each plot were removed leaving plots 15 feet long for which yields were determined. Thus, a 2-foot buffer strip between all plots was provided. The potatoes were graded over a hand grader and yields given are in bushels of U. S. No. 1 tubers. In 1950 carrots were topped prior to weighing but not in 1951 and 1952. Records of the amounts of root-knot damage and diseases present were

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[3]See Table 6.

Table 1. Summary of taste tests on potatoes grown in 1950 in plots treated in 1949 with various soil fumigants and other chemicals, each at dosages recommended for annual applications and at single dosages based on amounts normally applied in 10 years.

Material	Dosage (lb/acre)	No. of opinions[a]	% of opinions[b] rating samples as indicated off-flavor: None	Weak	Moderate	Strong	Objectionable
None (unknown check)	---	254	87	8	2	2	1
D-D mixture	250	34	88	9	0	3	0
D-D mixture	500	33	73	12	12	3	0
D-D mixture	5000	37	54	11	8	19	8
Dowfume N	250	37	55	32	8	5	0
Dowfume N	500	35	77	14	6	0	3
Dowfume N	5000	38	15	24	24	21	16
Ethylene dibromide	25	34	70	24	3	3	0
Ethylene dibromide	50	33	76	15	6	0	3
Ethylene dibromide	500	36	63	17	14	0	6
Dichlorobutenes	250	32	66	16	9	6	3
Dichlorobutenes	500	33	43	27	12	9	9
Dichlorobutenes	5000	-	-	-	-	-	-
Propylene dichloride	250	23	77	18	5	0	0
Propylene dichloride	2500	32	91	9	0	0	0
Eston Thinner	300	30	67	20	10	3	0
Eston Thinner	3000	39	87	8	5	0	0
Westvaco Thinner	300	34	64	24	6	6	0
Westvaco Thinner	3000	33	67	18	6	9	0
Stanisol	300	35	80	11	9	0	0
Stanisol	3000	34	82	9	3	6	0
Xylene	250	35	85	6	3	3	3
Xylene	2500	33	82	12	6	0	0
Chloropicrin	500	34	76	18	3	3	0
Chloropicrin	5000	32	82	9	9	0	0
Carbon tetrachloride	60	37	76	8	8	5	3
Carbon tetrachloride	200	37	64	22	8	3	3

[a]An unknown check was included in each test. Taste panel for each test was selected from those available of a group of about 25 persons, hence panels for all tests did not consist of the same individuals.
[b]Calculated from combined data of three separate tests on each sample, except for samples treated with 3000 pounds of Stanisol, which were examined in two tests only.

Table 2. Summary of taste tests on carrots grown in 1950 in plots treated in 1949 with various soil fumigants and other chemicals, each at dosages recommended for annual applications and at single dosages based on amounts normally applied in 10 years.

Material	Dosage (lb/acre)	No. of opinions[a]	% of opinions[b] rating samples as indicated off-flavor: None	Weak	Moderate	Strong	Objectionable
None (unknown check)	---	255	75	16	4	3	2
D-D mixture	250	37	32	19	14	11	24
D-D mixture	500	40	52	20	13	10	5
D-D mixture	5000	44	30	25	20	11	14
Dowfume N	250	42	57	21	10	7	5
Dowfume N	500	37	59	16	11	11	3
Dowfume N	5000	33	52	18	18	6	6
Ethylene dibromide	25	37	43	22	22	5	8
Ethylene dibromide	50	41	38	15	15	20	12
Ethylene dibromide	500	41	58	27	10	5	0
Dichlorobutenes	250	35	54	20	14	6	6
Dichlorobutenes	500	44	30	18	18	7	27
Dichlorobutenes	5000	-	-	-	-	-	-
Propylene dichloride	250	34	58	12	18	9	3
Propylene dichloride	2500	40	44	15	10	18	13
Eston Thinner	300	35	50	9	23	9	9
Eston Thinner	3000	42	52	14	19	10	5
Westvaco Thinner	300	35	63	20	11	6	0
Westvaco Thinner	3000	43	38	21	23	9	9
Stanisol	300	39	56	18	8	13	5
Stanisol	3000	22	63	5	14	9	9
Xylene	250	42	41	31	12	14	2
Xylene	2500	36	47	17	22	3	11
Chloropicrin	500	44	44	18	25	11	2
Chloropicrin	5000	38	32	21	21	13	13
Carbon tetrachloride	60	37	48	27	19	3	3
Carbon tetrachloride	200	41	54	12	20	12	2

[a]An unknown check was included in each test. Taste panel for each test was selected from those available of a group of about 25 persons, hence panels for all tests did not consist of the same individuals.
[b]Calculated from combined data of three separate tests on each sample, except for samples treated with 3000 pounds of Stanisol, which were examined in two tests only.

Table 3. Yields of carrots and potatoes on chemical residue plots, Riverhead, Long Island, 1950, 1951, 1952.

Treatment	Dosage (lb/acre)	Years applied	Yields[a] - Bushels per acre of U. S. no. 1: carrots 1950	carrots 1951	carrots 1952	potatoes 1950	potatoes 1951	potatoes 1952
Check	---		567	816	720	583	420	222
D-D mixture	250	1949, 1950, 1951	537	841	795	565	546°°	279
D-D mixture	500	1949, 1950, 1951	607	866	698	562	477°	231
D-D mixture	5000	1949	449	802	666	396**	444	278
Propylene dichloride	250	1949, 1950	505	813	688	488*	459	257
Propylene dichloride	2500	1949	604	804	709	542	483°	303
Eston Thinner	300	1949, 1950	623	866	795	550	427	281
Eston Thinner	3000	1949	628	834	742	527	434	249
Westvaco Thinner	300	1949, 1950	604	849	795	542	453	319
Westvaco Thinner	3000	1949	529	852	677	542	429	269
Dowfume N	250	1949, 1950, 1951	720	859	742	580	470°	329
Dowfume N	500	1949, 1950, 1951	588	917°	784	558	471°	250
Dowfume N	5000	1949	432*	788	688	311**	455	310
Ethylene dibromide	25	1949, 1950, 1951	505	764	610	494	425	293
Ethylene dibromide	50	1949, 1950, 1951	677	806	645	553	495°	306
Ethylene dibromide	500	1949	653	780	720	535	430	322
Stanisol	300	1949, 1950	510	834	763	545	433	312
Stanisol	3000	1949	591	770	698	521	480°	238
Xylene	250	1949, 1950	607	852	731	532	455	285
Xylene	2500	1949	672	759	688	518	505°	262
Chloropicrin	500	1949, 1950, 1951	596	891°	677	599	480°	342
Chloropicrin	5000	1949	594	770	763	641	508°	313
Dichlorobutenes	250	1949, 1950, 1951	596	856	688	597	481°	315
Dichlorobutenes	500	1949, 1950, 1951	623	951°°	623	606	451	260
Dichlorobutenes	5000	1949	126**	838	698	0**	536°°	310
Carbon tetrachloride	60	1949, 1950	578	813	655	504	416	292
Carbon tetrachloride	200	1949	545	917°	827	524	473°	275
LSD at 19:1			150	66		93	43	
LSD at 99:1			199	104		123	68	

[a]Weight of tops included in yields for 1951, 1952, not in 1950.

° Increase over check at 19:1
°° Increase over check at 99:1
* Decrease from check at 19:1
** Decrease from check at 99:1

Table 4. Summary of taste tests on potatoes grown in 1951 in plots treated in 1949 and 1950 with various soil fumigants and other chemicals, each at dosages recommended for annual applications and at single dosages based on amounts normally applied in 10 years.

Material	Dosage (lb/acre)	No. of opinions[a]	% of opinions[b] rating samples as indicated off-flavor: None	Weak	Moderate	Strong	Objectionable
None (unknown check)	---	84	82	8	6	2	2
None (known check)	---	84	97	1	2	0	0
D-D mixture	500	36	75	19	0	6	0
D-D mixture	5000	35	85	9	6	0	0
Dowfume N	500	35	82	9	3	6	0
Dowfume N	5000	34	82	12	6	0	0
Ethylene dibromide	50	36	71	14	6	3	6
Ethylene dibromide	500	36	77	17	3	3	0
Dichlorobutenes	250	36	83	8	6	0	3
Dichlorobutenes	500	38	68	13	13	3	3
Dichlorobutenes	5000	24	75	13	8	0	4
Chloropicrin	5000	36	66	22	6	3	3

[a]An unknown check was included in each test. Taste panel for each test was selected from those available of a group of about 25 persons, hence panels for all tests did not consist of the same individuals.
[b]Calculated from combined data of three separate tests on each sample.

Table 5. Summary of taste tests on carrots grown in 1951 in plots treated in 1949 and 1950 with various soil fumigants and other chemicals, each at dosages recommended for annual applications and at single dosages based on amounts normally applied in 10 years.

Material	Dosage (lb/acre)	No. of opinions[a]	% of opinions[b] rating samples as indicated off-flavor: None	Weak	Moderate	Strong	Objectionable
None (unknown check)	---	102	58	15	10	12	5
None (known check)	---	102	88	8	1	1	2
D-D mixture	500	45	44	16	20	11	9
D-D mixture	5000	44	30	25	16	20	9
Dowfume N	500	44	50	16	14	11	9
Dowfume N	5000	42	38	24	14	7	17
Ethylene dibromide	50	47	36	28	21	9	6
Ethylene dibromide	500	43	44	14	28	12	2
Dichlorobutenes	250	43	42	23	7	14	14
Dichlorobutenes	500	41	36	17	15	15	17
Dichlorobutenes	5000	30	33	23	17	17	10
Chloropicrin	5000	43	68	16	12	2	2

[a]An unknown check was included in each test. Taste panel for each test was selected from those available of a group of about 25 persons, hence panels for all tests did not consist of the same individuals.
[b]Calculated from combined data of three separate tests on each sample.

Table 6. Composition of commercial materials applied to residue plots.

Material	Composition
Chloropicrin	trichloronitromethane
D-D mixture	1,3-dichloropropene; 1,2-dichloropropane
Dichlorobutenes	1,4-dichloro-2-butene
Dowfume N	1,3-dichloropropene; 1,2-dichloropropane
Eston Thinner	Petroleum thinner
Ethylene dibromide	1,2-dibromoethane
Propylene dichloride	1,2-dichloropropane
Stanisol	Petroleum thinner
Westvaco Thinner	Petroleum thinner

made. The cauliflower plants were dug with a potato digger and the roots scored for club-root. During harvest random samples of carrots and potatoes were removed from each plot for the taste determinations.

The taste tests were run by cooking approximately 2 pounds as a sample. Both carrots and potatoes were peeled. The carrots were sliced and the potatoes sectioned for cooking. An equal amount of water and salt was added to each sample before cooking and the samples were cooked for a given length of time. The carrots were served sliced and the potatoes were mashed. The judges served themselves from the cooking pots -- any amount desired -- to numbered paper cups. Tests on the carrots were run separately from the potatoes. Five treatments with a check and known check, for comparison, were included in each test. Samples, except for the known check, were listed only by number. At least 10 judges made comparisons for each test. Thus there were at least 30 opinions in the three replications for each treatment. Judges were asked to record their opinion for each sample on a printed form as to the off-flavor, if any, as regards taste and odor. If they judged the sample to be off-flavor, compared with the standard known check, they were to classify it as objectionable, strong, moderate, or weak.

RESULTS

Yields: Both carrot and potato yields were reduced significantly the first year (Table 3) with an application of 5000 pounds of D-D, Dowfume N and dichlorobutenes. No potatoes emerged on the plots treated with 5000 pounds of dichlorobutenes and the carrots were stunted and roots highly pronged. Consequently, samples of potatoes and carrots from this treatment were not available for taste tests the first year.

Off-flavor: The results (Tables 1, 2, 4, and 5) are shown as the total number of opinions in each designated flavor class in the three replications over the total judgments given. The most consistent data were obtained from the potato samples. Wide variability was evident in the carrot samples. The only off-flavoring consistently reported was in D-D and Dowfume N at the 10-year dosage of 5000 pounds. The annual treatment of 500 pounds of dichlorobutenes resulted in significant off-flavor in carrots but not in potatoes.

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