Supplement to Journal of Nematology 22(4S):767–774. 1990.

Effects of Soil Fumigants and Aldicarb on Nematodes, Tuber Quality, and Yield in Potato[1]

D. P. WEINGARTNER AND J. R. SHUMAKER[2]

Abstract: Efficacy of the fumigants ethylene dibromide (EDB), EDB + chloropicrin, and 1,3-dichloropropene (1,3-D) applied with one or three chisels per row, singly or in combination with aldicarb, was evaluated in 1982 and 1983 on potato (*Solanum tuberosum*) cultivars Atlantic and Sebago for control of several nematodes, including *Belonolaimus longicaudatus, Meloidogyne incognita,* and trichodorids. Generally, nematode populations were lowest following application of fumigants with three chisels per row, following EDB or EDB + chloropicrin, and when fumigants were applied in combination with aldicarb. These treatment combinations also resulted in highest yields in 1983. Cosmetic appearance of tubers was improved ($P \leq 0.05$) by aldicarb in 1982. Both bacterial wilt and nematodes reduced yield; however, stepwise multiple regression analysis estimated that the greater loss in yield was associated with bacterial wilt, especially in Atlantic during 1983. Economic analysis showed that addition of aldicarb to all 1,3-D treatments increased profits. The increase was greater in Atlantic than in Sebago. Triple-chisel fumigation produced greater profits than single-chisel fumigation in Atlantic during both years and in Sebago in 1982.

Key words: aldicarb, bacterial wilt, *Belonolaimus longicaudatus,* corky ringspot, *Meloidogyne incognita, Paratrichodorus minor,* potato, *Pseudomonas solanacearum,* soil fumigation, *Solanum tuberosum,* tobacco rattle virus, trichodorid, *Trichodorus proximus, Trichodorus viruliferous.*

Potato (*Solanum tuberosum* L.) grown in northeast Florida is host to a complex pathosystem including several different genera of phytoparasitic nematodes (10–13), corky ringspot disease (CRS) (8,11), and bacterial wilt (*Pseudomonas solanacearum* E. F. Smith) (9,10). Efficacy of triple-chisel and single-chisel applications of soil fumigants used singly and in combination with aldicarb for control of CRS and trichodorids (8) and of bacterial wilt and *Meloidogyne incognita* (Kofoid & White) Chitwood (9) have been discussed previously. In this paper we evaluate the use of triple-chisel and single-chisel applications of ethylene dibromide (EDB), EDB + chloropicrin (Pic), and 1,3-dichloropropene (1,3-D), both singly and in combination with aldicarb, on nematode populations and yield and quality of tubers in the potato cultivars Atlantic and Sebago. In addition, the relative impact of nematodes, CRS, and bacterial wilt on potato yields and the economics of control are discussed.

Received for publication 7 March 1990.
[1] Florida Agricultural Experiment Station Journal Series No. R-00546.
[2] Associate Professors, IFAS Agricultural Research and Education Center, Hastings, FL 32145.
We thank Jill Meldrum and Louis Wallis III for technical assistance.

MATERIALS AND METHODS

The raised-bed cultural system used for potato production in northeastern Florida (1,2,4,8,9) and the soil characteristics of the potato field in which these experiments were performed have been described previously (8,9). The nematodes present in the pathosystem in 1982 and 1983 included *M. incognita,* trichodorids (mixed populations of *Paratrichodorus minor* (Colbran) Siddiqi, *Trichodorus viruliferous* Hooper, and *T. proximus* Allen), *Belonolaimus longicaudatus* Rau, *Pratylenchus* spp. (principally *P. zeae* Graham and *P. scribneri* Steiner), *Hemicycliophora* sp., *Criconemella ornata* (Raski) Luc & Raski, *Tylenchorhynchus claytoni* Steiner, and *Helicotylenchus* spp. The presence of nematodes in the experimental field had been verified by numerous soil samples in experiments performed previously, and therefore no randomized pretreatment samples were taken.

Details of the plot design and treatment details were as described previously (8), and only pertinent details are reported here. In both experiments (1982 and 1983), the plot design was a three-level split-plot coupled with a split-strip with six replications. The sub-subplots were 7.6 m long and four rows wide with 1.0-m spacing between rows.

TABLE 1. Mean squares from analysis of variance for nematode populations, tuber yields, and tuber appearance following treatment of potatoes with single-chisel or triple-chisel injections of soil fumigants used singly or in combination with aldicarb, 1982.

Source of variation	df	Appearance	Yield	*Belonolaimus longicaudatus*	*Pratylenchus* spp.	*Criconemella ornata*	Total nematodes†
Replication	5	2.02	269.97	2.74	2.54	18.23	20.57
No. chisels/row (C)	1	1.82	110.77	9.62	32.53**	85.42*	681.12**
Error a	5	6.85	556.11	2.42	0.95	11.54	34.22
Variety (V)	1	0.02	7.98	0.01	1.53	48.08	282.46**
Error b	5	2.15	143.70	1.81	1.04	23.82	6.28
V × C	1	5.52	221.76	1.76	2.46	6.82	46.90
Error c	5	1.14	75.33	0.97	0.97	4.64	12.37
Fumigant (F)	2	20.43*	92.77	19.11**	3.65**	140.99**	309.47**
F × C	2	9.84*	351.87*	2.93	6.25**	19.39*	50.64*
F × V	2	1.80	115.16	0.33	0.87	2.88	37.08
F × C × V	2	1.69	0.74	0.75	0.11	0.09	13.57
Error d	40	1.23	86.31	1.48	0.53	6.07	13.86
Nematicide (N)‡	1	131.10*	720.47**	25.16**	3.29	0.02	426.22**
N × C	1	4.01	54.89	5.54	3.58**	0.13	34.18
N × V	1	15.08**	10.51	0.19	0.06	1.05	132.60**
N × F	1	6.77*	177.68	15.48**	0.04	4.65	116.01
N × C × V	1	1.66	15.53	0.99	0.34	1.43	0.14
N × C × F	2	0.76	77.44	1.62	0.11	6.48	35.52**
N × V × F	2	0.46	8.13	1.47	1.59*	0.66	48.24**
N × C × V × F	2	1.16	27.17	0.06	0.47	1.23	0.56
Error e	60	1.92	81.26	1.62	0.45	4.38	10.88

* $P \leq 0.05$; ** $P \leq 0.01$.
† Total nematodes include *M. incognita*, trichodorids, *Hemicycliophora* spp., *Tylenchorhynchus claytoni* and *Helicotylenchus* sp. in addition to those shown in table. Nematode data were transformed to $\sqrt{\text{nematodes} + 1}$ prior to ANOVA.
‡ The nonfumigant nematicide, aldicarb.

The varieties were planted adjacent to each other so that the center two rows (i.e., data rows) consisted of one row of each variety.

The fumigants were applied using either the standard single-chisel method of application or three chisels per row, which served as a simulated broadcast treatment. The fumigant rates applied in the 1982 experiment were EDB, 16.8 liters/ha (52 ml/chisel per 30.5 m); 54% EDB + 45% Pic, 23.9 liters/ha (74 ml/chisel per 30.5 m); and 1,3-D, 56.1 liters/ha (174 ml/chisel per 30.5 m). The rates were identical in 1983 except that EDB was applied at 12.6 liters/ha (39 ml/chisel per 30.5 m). Aldicarb was banded over the seed pieces at a rate of 3.4 kg a.i./ha (10.4 g/30.5 m of row).

Soil samples for nematode assay were taken just before harvest each year. Ten soil cores, each 2.5 cm d × 20–25 cm deep, were taken within each data row of each sub-subplot. Soil samples from individual rows were processed separately in 1982, whereas the samples from the two data rows of each plot were bulked in 1983. Nematodes were extracted from 100-cm^3 aliquants with a modification of the sugar centrifugation method (3).

The plots were harvested mechanically each year. Harvest dates were 26 May 1982 (102 days after planting) and 2–3 June 1983 (107–108 days after planting). Potato tubers were washed, graded into size classes, and weighed. Yield data are expressed as weights of U.S. Size A tubers (i.e., tubers > 4.75 cm d). Tuber appearance was rated in 1982 on a scale of 1–10 with 1 = tubers free of defects and 10 = surface of all tubers affected. Ratings exceeding 7 are considered unmarketable.

All data were subjected to analysis of variance (ANOVA). Nematode data were transformed to $\sqrt{\text{nematodes} + 1}$ prior to ANOVA. Relationships between tuber yields and selected independent variables

TABLE 2. Mean squares from analysis of variance for nematode populations and tuber yields following treatment of potatoes with single-chisel or triple-chisel injections of soil fumigants used singly or in combination with aldicarb, 1983.

Source of variation	df	Yield	*Belonolaimus longicaudatus*	*Pratylenchus* spp.	*Criconemella ornata*	*Hemicycliophora* sp.	Total nematodes†
Replication	5	258.96	0.28	2.90	43.41	27.53	11.17
No. chisels/row (C)	1	4,412.28*	45.17	127.97**	299.27*	564.93**	4,530.25**
Error a	5	763.23	0.89	2.54	32.41	19.06	37.27
Variety (V)	1	1,082.96					
Error b	5	396.60					
V × C	1	1,448.44					
Error c	5	429.87					
Fumigant (F)	2	315.62*	5.94**	0.74	123.35**	20.65	644.94**
F × C	2	157.19	4.40*	2.33	46.95	26.01	391.91**
F × V	2	63.07					
F × C × V	2	101.73					
Error d	40	62.57	0.86	1.67	15.65	17.28	43.38
Nematicide (N)‡	1	2,499.17**	32.95**	5.82	0.58	16.78	1,165.64**
N × C	1	68.20	17.40**	2.72	0.33	23.14	165.60*
N × V	1	168.35					
N × F	2	142.17*	0.42	2.31	0.89	0.09	25.96
N × C × V	1	167.92					
N × C × F	2	69.03	0.74	1.43	4.22	22.36	177.49
N × V × F	2	33.21					
N × C × V × F	2	108.13					
Error e	60	48.43	1.33	2.28	5.49	7.97	23.13

* $P \leq 0.05$; ** $P \leq 0.01$.

† Total nematodes include *M. incognita*, trichodorids, *Tylenchorhynchus claytoni* and *Helicotylenchus* spp. in addition to those shown in table. Respective degrees of freedom for error terms a, b, and c for nematodes were 5, 20, and 30. Nematode data were transformed to $\sqrt{\text{nematodes} + 1}$ prior to ANOVA.

‡ The nonfumigant nematicide, aldicarb.

were estimated by stepwise multiple regression analysis (5).

RESULTS

Analysis of variance revealed several significant ($P \leq 0.05$) effects and interactions in 1982 (Table 1) and 1983 (Table 2).

Tuber yield: Heavy rains occurred shortly after fumigation in 1982. Compared with plants in unfumigated plots of other experiments, the size of plants in this experiment was reduced, especially in the triple-chisel plots and those fumigated with EDB. Severe phytotoxicity in potatoes had been encountered previously in EDB fumigated fields in northeastern Florida following cold, wet soil conditions which apparently trapped EDB in the soil (unpubl. data).

In 1982, triple-chisel 1,3-D plots produced greater tuber yields than did the single-chisel 1,3-D or the triple-chisel EDB and EDB + Pic treatments (Table 3). All other differences in yield among the soil fumigants in 1982 were not significant ($P \leq 0.05$). Addition of aldicarb to the soil fumigation treatments further increased yields (Table 3). There were no differences between yields of the two potato cultivars in 1982.

In 1983 there were significant fumigant, aldicarb, fumigant × number of chisels, and fumigant × aldicarb effects on yields (Tables 2, 3). The greatest yields were produced in EDB + Pic plots; however, these were not greater ($P \leq 0.05$) than those with 1,3-D. Fumigants applied with three chisels resulted in greater yields than those applied with the single-chisel methods. As in 1982, addition of aldicarb to fumigation treatments increased yields over treatments in which the fumigants were used alone. Although the increased yield associated with aldicarb occurred with all of the soil fumigants, the increase was great-

TABLE 3. Tuber yield following use of nematicides, 1982 and 1983.

	U.S. Size A tubers (t/ha)					
	1982			1983		
Nematicide treatment†	One chisel	Three chisels	Means	One chisel	Three chisels	Means
EDB						
+ aldicarb	26.5	29.1	27.8	20.3	26.9	23.6 vw
− aldicarb	26.4	25.0	25.7	11.3	22.5	16.9 z
EDB chisel means	26.5 b	27.1 b		15.8	24.7	
EDB means	26.8			20.3 q		
EDB + chloropicrin (Pic)						
+ aldicarb	29.6	26.8	28.2	23.6	28.0	25.8 v
− aldicarb	28.0	27.0	27.6	17.9	23.5	20.7 xy
EDB + Pic chisel means	28.8 ab	27.0 b		20.8	25.8	
EDB + Pic means	27.9			23.3 p		
1,3-D						
+ aldicarb	28.1	33.6	30.9	19.9	26.0	23.0 wx
− aldicarb	24.1	27.4	25.8	17.7	22.7	20.2 y
1,3-D chisel means	26.1 b	30.5 a		18.8	24.4	
1,3-D	28.3			21.6 pq		
Overall chisel means						
+ aldicarb	28.1	29.8	29.0 n	21.3	27.0	24.1 n
− aldicarb	26.2	26.5	26.3 m	15.6	22.9	19.3 m
Chisel means	27.1	28.2		18.5 h	24.9 i	

Data are averaged across both cultivars. Values within a treatment level (application method [h–i], fumigant [p–q], aldicarb [m–n], application method × fumigant [a–b], or fumigant × aldicarb [v–z]) for an individual year followed by the same letter do not differ significantly ($P \leq 0.07$ for 1983 fumigant × aldicarb comparisons and $P \leq 0.05$ for all others) according to Duncan's multiple range test. Absence of letters within a treatment level indicates no significant differences.

† Respective per chisel dosages of EDB, EDB + Pic, and 1,3-D during 1982 were 16.8, 23.9, and 56.1 liters/ha. Per chisel dosages during 1983 were the same except for EDB which was applied at 12.6 liters/ha.

est with EDB. When 1983 yields were averaged across all nematicide treatments, Atlantic produced 23.3 t/ha as compared to 20.0 t/ha for Sebago.

Tuber appearance: One of the most noticeable effects of nematicides on potato in northeastern Florida is an improvement in cosmetic appearance of tubers, presumedly due to reduced tuber damage associated with nematode feeding activity. The periderm of untreated tubers is often dull, rough, and scurfy in appearance, whereas that of tubers from treated plots is usually brighter, cleaner, and more visibly acceptable (15).

Among the three soil fumigants used, 1,3-D resulted in the best quality tubers, especially when the fumigant was applied with three chisels per row (Table 4). Addition of aldicarb to soil fumigants further improved quality. There also was an aldicarb × cultivar interaction (Table 1). Following the aldicarb treatment, Sebago tubers had a significantly ($P \leq 0.05$) better rating (2.2) than Atlantic tubers (2.9). There was no difference in quality between cultivars when aldicarb was not used.

Nematode population densities: Data on trichodorids and *M. incognita* were presented previously (8,9). Populations of *M. incognita* were generally smallest when the fumigants were applied with three chisels per row in combination with aldicarb. In the absence of aldicarb, both EDB and EDB + Pic were more effective in reducing *M. incognita* than was 1,3-D (9). In both seasons, plots treated with aldicarb had fewer trichodorids than plots without aldicarb. Fumigants and fumigant × dosage effects on trichodorids were noted in 1982, but not 1983 (8).

Compared with previous seasons (14), populations of *B. longicaudatus* were relatively low (<20 nematodes/100 cm^3 soil).

TABLE 4. External appearance of potato tubers following use of nematicides, 1982.

Nematicide treatment	Tuber appearance: One chisel	Three chisels	Means
EDB			
+ aldicarb	2.4	3.7	3.0 xy
− aldicarb	4.9	5.8	5.4 yz
EDB chisel means	3.7 b	4.8 c	
EDB mean	4.2 r		
EDB + PIC			
+ aldicarb	2.1	2.0	2.3 x
− aldicarb	4.7	4.7	4.7 z
EDB + Pic chisel means	3.4 b	3.7 b	
EDB + Pic mean	3.5 q		
1,3-D			
+ aldicarb	2.4	2.3	2.4 x
− aldicarb	4.1	2.8	3.4 y
1,3-D chisel means	3.3 b	2.5 a	
1,3-D mean	2.9 p		
Overall chisel means			
+ aldicarb	2.3	2.9	2.6 h
− aldicarb	4.5	4.4	4.5 i
Overall means	3.4	3.7	

Data are averaged across both potato cultivars. The appearance of potato tubers was rated on a scale of 1–10 with 1 = no surface defects and 10 = entire surface of all tubers affected. Values within a treatment level (application method [a–c], fumigant [p–r], aldicarb [h–i], fumigant × aldicarb [x–z]) followed by same letter do not differ significantly ($P \leq 0.05$) according to Duncan's multiple range test. Lack of letters at any level denotes no significant differences within the level.

Populations in 1982 were less in EDB and EDB + Pic plots than in those fumigated with 1,3-D (Table 5). Addition of aldicarb to 1,3-D alleviated this difference. The differences among fumigation treatments were not as large in 1983 (Table 5). The best control among fumigants in 1983 was in EDB + Pic plots. With the exception of EDB + Pic, fumigants applied with three chisels resulted in fewer *B. longicaudatus* than did the single-chisel treatments. Addition of aldicarb to single-chisel fumigation treatments reduced populations of *B. longicaudatus* from 18.0 to 3.5 per 100 cm^3 soil. The respective populations of triple-chisel treatments with and without aldicarb were 0.4 and 1.7 per 100 cm^3 soil. Thus as observed with other nematodes, addition of aldicarb to the fumigants applied with a single-chisel improved the level of *B. longicaudatus* control to approximately that of the triple-chisel treatment.

Counts of total nematodes (Table 6) include *Hemicycliophora* sp., *T. claytoni*, and *C. ornata* in addition to those discussed here. In 1982, 59% of the total nematodes were *M. incognita* and 16% were *C. ornata*; in 1983, these same nematodes constituted, respectively, 34% and 27% of the total. In both years, the lowest total nematode populations occurred in plots with EDB + Pic plus aldicarb (Table 6). Considering only the fumigants, EDB + Pic provided the best nematode control. With the exception of EDB in 1982, fumigants applied with three chisels per row performed better than did single-chisel applications. Generally, the addition of aldicarb to fumigation treatments resulted in enhanced nematode control. This latter trend was more pronounced in the 1,3-D treatment than with the other fumigants.

Stepwise multiple regression analyses using yield of U.S. Size A tubers as the dependent variable and bacterial wilt inci-

TABLE 5. Population densities of *Belonolaimus longicaudatus* at harvest following use of nematicides, 1982 and 1983.

Fumigation treatment	Nematodes/100 cm^3 soil: 1982: + aldicarb	1982: − aldicarb	1982: Means	1983: One chisel	1983: Three chisels	1983: Means
EDB	0 a	1 a	<1 x	14.9 e	0.3 d	7.6 y
EDB + Pic	<1 a	1 a	<1 x	3.3 d	0.7 d	2.0 x
1,3-D	1 a	19 b	10 y	13.8 e	2.3 d	8.0 y
Means	<1 h	7 i		10.7 p	1.1 q	

Values within a year and treatment level (fumigant [x–y], aldicarb [h–i], fumigant × aldicarb [a–b], application method [p–q], or fumigant × application method [d–e]) followed by the same letter do not differ significantly ($P \leq 0.05$) according to Duncan's multiple-range test.

TABLE 6. Population densities of total nematodes following use of nematicides, 1982 and 1983.

Nematicide treatment	Nematodes/100 cm^3 soil† 1982 One chisel	1982 Three chisels	1982 Means	1983 One chisel	1983 Three chisels	1983 Means
EDB						
+ aldicarb	66 c–e	52 bc	59 y	365 e	102 bc	233
− aldicarb	102 e	58 c–e	80 z	1,143 q	180 bc	661
EDB chisel means	84 q	55 q		754 r	141 pq	
EDB means	69 n			447 n		
EDB + Pic						
+ aldicarb	59 c–e	2 a	30 x	218 c–e	8 a	113
− aldicarb	82 de	14 ab	48 x	299 de	209 b–d	254
EDB + Pic chisel means	71 q	8 p		259 q	108 p	
EDB + Pic means	39 m			184 m		
1,3-D						
+ aldicarb	82 c–e	39 bc	61 yz	690 f	68 ab	379
− aldicarb	384 f	139 e	261 z	1,803 h	116 bc	960
1,3-D chisel means	233 r	89 q		1,247 s	92 p	
1,3-D means	161 o			669 n		
Overall chisel means		Aldicarb			Aldicarb	
+ aldicarb	69	31	50 v	420 l	59 i	242 v
− aldicarb	190	70	130 w	182 k	168 j	625 w
Overall means	129 u	51 t		753 u	114 t	

Values within a treatment level (application method [u–t], fumigant [m–o], aldicarb [v–w], application method × fumigant [p–s], fumigant × aldicarb [x–z], application method × fumigant × aldicarb [a–h], or application method × aldicarb [i–l]) followed by the same letter do not differ significantly ($P \leq 0.05$) according to Duncan's multiple-range test. Lack of a letter at any level denotes no significant differences.

† Total nematodes include *B. longicaudatus*, trichodorids, *M. incognita*, *Pratylenchus* spp., *Hemicycliophora* sp., *Tylenchorhynchus claytoni*, and *Criconemella ornata*.

dence, CRS incidence, and the densities of the eight different nematode genera as independent variables indicated that incidence of bacterial wilt was the most important factor affecting yields in both years. Wilt incidence had R^2 values of 0.347 in 1982 and 0.478 in 1983. In 1982, inclusion of CRS in the equation raised R^2 to 0.422, but addition of nematodes had a negligible effect on R^2. In 1983, inclusion of *M. incognita*, *B. longicaudatus*, and trichodorids in the calculations increased R^2 to 0.587 and to 0.654 when all nematodes were included. It is important to note that these relationships were all estimated in fumigated and (or) aldicarb-treated soil, and their relative importance may differ in untreated soil.

Discussion

The primary objective of the experiments reported here and elsewhere (8,9) has been to evaluate the efficacy of simulated broadcast applications of soil fumigants in a complex potato pathosystem. According to the multiple regression analyses, bacterial wilt had a major impact on tuber yields in these experiments. Atlantic was more severely affected than Sebago, but increasing the number of chisels increased control of wilt and generally improved tuber yields (9). Surprisingly, addition of aldicarb to fumigation treatments also generally improved yields even though it did not affect incidence of wilt.

A comparison of net profits ($/ha) from the various nematicide combinations is summarized (Table 7). Although the cost of EDB was less than that of 1,3-D, returns from 1,3-D treatment were comparable to those for the other fumigant during 1982. Since EDB is no longer registered for use in the United States, the remaining discussion is confined to 1,3-D. With the ex-

TABLE 7. Net profit ($/ha) following use of nematicides in Atlantic and Sebago potatoes, 1982 and 1983.

Nematicide treatment	One chisel			Three chisels		
	1982	1983	Mean	1982	1983	Mean
			Atlantic			
EDB						
+ aldicarb	1,226	452	839	1,343	1,956	1,650
− aldicarb	1,515	−600	457	948	1,807	1,378
EDB + Pic						
+ aldicarb	1,734	1,079	1,407	1,097	2,130	1,600
− aldicarb	1,786	760	1,273	1,102	1,227	1,165
1,3-D						
+ aldicarb	1,676	242	959	1,853	1,440	1,647
− aldicarb	1,177	402	790	1,223	1,262	1,243
			Sebago			
EDB						
+ aldicarb	1,515	959	1,237	1,907	1,195	1,551
− aldicarb	1,409	−332	539	1,434	298	866
EDB + Pic						
+ aldicarb	1,656	1,079	1,368	1,071	860	939
− aldicarb	1,392	−16	688	1,351	620	986
1,3-D						
+ aldicarb	1,269	834	1,052	1,985	788	1,382
− aldicarb	940	247	594	1,196	247	722

Net profit = yields (t/ha) × value/t − (cost to treat + cost to harvest and sell + growing costs). Fixed costs such as depreciation and land rental were not subtracted. Data on costs and crop value taken from other sources (6,7).

ception of the single-chisel 1,3-D plus aldicarb treatments in Atlantic during 1983, addition of aldicarb to fumigation treatments resulted in substantial increases in net profits. Because of differences in incidence of bacterial wilt, use of the triple-chisel 1,3-D treatment had greater economic benefit in Atlantic than in Sebago (Table 7).

The economic benefits of aldicarb shown (Table 7) are understated because losses due to CRS have not been considered. It is difficult to assess the precise economic impact of CRS because not all tubers affected with the disease are culled. Based on our experience, however, a reasonable estimate of losses in tubers affected by the disease would be 25%. Assuming a 25% loss of CRS-affected tubers and using infection data obtained previously (8), a comparison of losses in plots treated and not treated with aldicarb suggests additional losses of $389/ha in 1982 and $232/ha in 1983.

LITERATURE CITED

1. Campbell, K. L., J. S. Rogers, and D. R. Hensel. 1978. Water table control for potatoes in Florida. Transactions of the American Society of Agricultural Engineering 21:701–709.
2. Hensel, D. R. 1964. Irrigation of potatoes at Hastings, Florida. Proceedings of the Florida State Horticulture Society 24:105–110.
3. Miller, P. M. 1957. A method for quick separation of nematodes from soil samples. Plant Disease Reporter 41:194.
4. Rogers, J. S., D. R. Hensel, and K. L. Campbell. 1975. Subsurface drainage and irrigation for potatoes. Soil and Crop Science Society of Florida Proceedings 34:16–19.
5. Ryan, T. A., Jr., B. L. Joiner, and B. F. Ryan. 1982. Minitab reference manual. Minitab Project. Pennsylvania State University, University Park, PA.
6. Taylor, T. G., and G. H. Wilkowske. 1983. Costs and returns from vegetable crops in Florida, season 1981–82 with comparisons. Information Report 186, Food and Resource Economics Department, University of Florida, Gainesville.
7. Taylor, T. G., and G. H. Wilkowske. 1984. Costs and returns from vegetable crops in Florida, season 1982–83 with comparisons. Information Report 199, Food and Resource Economics Department, University of Florida, Gainesville.
8. Weingartner, D. P., and J. R. Shumaker. 1990.

Effects of soil fumigants and aldicarb on corky ringspot disease and trichodorid nematodes in potatoes. Supplement to the Journal of Nematology (Annals of Applied Nematology) 22:665–671.

9. Weingartner, D. P., and J. R. Shumaker. 1990. Effects of soil fumigants and aldicarb on bacterial wilt and root-knot nematodes in potato. Supplement to the Journal of Nematology (Annals of Applied Nematology) 22:681–688.

10. Weingartner, D. P., and J. R. Shumaker. 1984. Bacterial wilt and tuber brown rot as a potential threat to potato production in northeast Florida. Proceedings of the Florida State Horticultural Society 97: 198–200.

11. Weingartner, D. P., J. R. Shumaker, and G. C. Smart, Jr. 1983. Why soil fumigation fails to control corky ringspot disease in Florida. Plant Disease 67: 130–134.

12. Weingartner, D. P., and J. R. Shumaker. 1983. Nematicide options for northeast Florida potato growers. Proceedings of the Florida State Horticultural Society 96:122–127.

13. Weingartner, D. P., and J. R. Shumaker. 1981. Comparisons of nematode control and potato yields in large plots treated with different nematicide combinations during 1977–1981. Proceedings of the Florida State Horticultural Society 94:141–144.

14. Weingartner, D. P., J. R. Shumaker, and R. C. Littell. 1979. Sting nematode (*Belonolaimus longicaudatus* Rau) damage to potatoes in northeast Florida. American Potato Journal 54:505–506 (Abstr.).

15. Weingartner, D. P., J. R. Shumaker, D. W. Dickson, and G. C. Smart, Jr. 1974. Improving the quality of potato tubers through use of nematicides. Soil and Crop Science Society of Florida Proceedings 33:67–72.