FINAL REPORT OF THE PROJECT SANCTIONED UNDER THE EMERITUS SCIENTISTS' SCHEME OF THE I.C.A.R. FOR THE PERIOD 1 - 6 - 1978 TO 31 - 5 - 1980.

SECTION A - General

1. Name of the Scientist: Dr. M.R.G.K. Nair.

2. Title of the project: 'Insecticide residues on crops and their produces'.

3. Location: College of Agriculture, Vellayani 695 522, Trivandrum, Kerala State.

4. Period covered in the report: 1--6--1978 to 31--5--1980.

5. Objectives of the Project:

   i. To study persistence of insecticides recommended for insect control on different crops in Kerala.

   ii. To study contamination of agricultural commodities by recommended insecticide applications.

6. Period for which sanctioned: Two years.

7. Date of commencement of the work on the project: 1st June, 1978.

8. Date on which the sanction expired: 31st May, 1980.

9. Total amount sanctioned (under different heads):

i.	Honorarium @ Rs.750/ p.m.	Rs. 18,000.00
ii.	Salary of one Senior Research fellow @ Rs.400/- p.m.	9,600.00
iii.	Contingent grant	5,000.00
	Total	Rs. 32,600.00

10. Total amount spent (under different heads):

i.	Honorarium	Rs. 16,500.00
ii.	Salary of Senior Research Fellow	3,935.45
iii.	Contingencies	6,455.77
	Total	Rs. 26,891.22

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11. Receipts realised, if any : Nil.

12. Research fellows employed if any with the pay, qualification and the date since employed: Sri. George Koshy, M.Sc.(Ag.) Employed at Rs.400/- p.m. from 20th October 1978 to 14th August 1979.

SECTION B - Technical Programme.

1. Technical Programme for the entire period of the project:

i. Dissipation of Insecticide Residues from plants:

Persistence of residues of recommended insecticides on rice, fruits of bhindi, brinjal and bitter gourd, cowpea pods and on sweet potato tuber will be determined by bioassay.

ii. Insecticide residues as contaminants of crop produces:

Residue of recommended insecticides on pepper, cardamom, ginger, rice and banana will be determined by bioassay.

SECTION C - RESULTS.

REPORT OF WORK DONE.

INTRODUCTION

Health hazards due to insecticide residues on consumable articles form an inherent side effect of insecticidal use in crop pest control. This realisation led international organizations like FAO and WHO and the U.S.A. Food and Drugs Administration to lay down precise standards for safe use of insecticides. The basis of these standards is fixing tolerance limits for the insecticides when used on different crops. Once the tolerance limit is fixed, safety in insecticide use can be ensured by determining the period which should elapse after application of insecticide for the insecticide residues to fall below the tolerance limit. This is the 'Waiting period'. Strict adherence to the waiting period in relation to harvest will eliminate by and large the risks of residue hazards.

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Persistence of residues of insecticides on crops will depend upon various intrinsic and extrinsic factors among which the climatic environment is important. The present research programme was hence proposed to determine the persistence of insecticide residues on some crop produces under the climatic environment of Kerala. The programme proposed had 2 aspects. One consisted of determining the persistence of insecticide residues on rice, fruits of bhindi, brinjal, and bitter gourd, cowpea pods and sweet potato tubers. The second consisted of determination of insecticide residues occurring as contaminants of commodities such as pepper, cardamom, ginger, rice and banana. During the period of the scheme work was concentrated on vegetable crops as that was considered of vital importance in Kerala. As regards the other plant produces proposed under the scheme, studies on insecticide residues on pepper were undertaken by a Ph.D. student under my guidance and those on cardamom were included in a research project of the Department of Entomology here. Work on residues of insecticides in banana is nearing completion under a project of the Department and that on rice has been completed already under a p.g. programme of the department.

Details of work done on vegetable crops and its results are presented below:-

Review of literature:

Review of work done elsewhere in India on the insecticide residues on the vegetables included under the present studies is given below:-

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Bhindi.

When malathion was sprayed on bhindi fruits at 0.05 and 0.1 percent concentrations the residue fell below the tolerance limit of 3 ppm in 3 hours and below detectable levels in 5 days with the former concentration and below 3 ppm in 2 days and below detectable levels in 5 days with the latter concentration. Washing in water removed the deposits up to 84.95 and 77.7 percent under the two concentrations (Jat et. al. 1973). An initial deposit of 14.40 ppm of carbaryl on bhindi from sprays of 0.1% was reduced below tolerance limit in 3 days (Raghuraj et.al. 1973). Deposits of 0.1 and 0.2% sprays of endosulfan on bhindi fruits dissipated rapidly during the first 2 days but the residues were above the tolerance limit of 2 ppm up to 6 days. Washing reduced the deposits by 34.67 to 48.94% but not below tolerance limit (Nath et.al. 1974). On the other hand studies made of 4 sprays of endosulfan at fortnightly intervals at 0.25 kg ai/ha showed that the initial deposits of the insecticide in these cases were below the tolerance limit of 2 ppm and there were no detectable residues after 7 days. (These were GLC determinations) (Singh et.al. 1974). Endosulfan Joia et.al. (1974) also found that the initial deposits of endosulfan on bhindi fruits were below tolerance limit. In this case the initial deposit was 0.16 ppm which was reduced to 0.07 ppm in 2 days. Further, fenitrothion with an initial deposit of 0.14 ppm (this was less than the tolerance limit of 0.2 ppm) was reduced to 0.014 ppm in 2 days. Fenthion also left an initial deposit less than the tolerance limit of 0.5 ppm on bhindi fruit; the initial deposit was 0.22 ppm which was reduced to 0.07 ppm in

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2 days. Sprays of malathion had left an initial deposit of 0.22 ppm which was less than tolerance limit and this was reduced to 0.02 ppm in 2 days.

Dixit et.al. (1975) detected an initial deposit of 0.41 ppm of endosulfan on bhindi fruits when sprayed with 0.05% emulsion. This was reduced to 0.06 ppm in 7 days. Even the initial deposit was below the tolerance limit of 2 ppm. For malathion 0.05% sprays a waiting period of 7 days was suggested on the fruits and residues were at non-detectable level in 7 days. On the contrary Deshmukh and Singh (1975) showed malathion sprays did not leave deposits above tolerance limit on bhindi fruits. They found that in the case of carbaryl sprays also the initial deposit was below the tolerance limit of 10 ppm on the fruits. The deposit was removed to the extent of 79 - 95% from the fruits when washed under tap water. Krishniah et.al. (1975) found that carbaryl sprays at 1 and 2 kg ai/ha left on the fruits deposits of 7.63 and 11.07 ppm respectively and these were reduced to residues of 0.07 and 0.1 ppm respectively in 10 days. Washing fruits after one hour of spray reduced the residues by 69 - 71% bringing them below tolerance limits.

Rajakannu et.al. (1976) found that sprays of 0.07% endosulfan left an initial deposit of 2.74 ppm on the fruits and this was reduced to 0.32 ppm in 10 days. A waiting period of 3 days was proposed for this. Carbaryl as 0.1% spray left a deposit of 15.92 ppm on the fruits and the residues were below tolerance limit in 3 days. Washing reduced the deposits on the fruits by 45 - 60%. Studies of Srivastava et.al. (1976) showed that residues of carbaryl on the fruits from 0.25% sprays decreased to levels below tolerance limit of 10 ppm

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in 24 hours. Washing removed 66.12% of the deposit.

Brinjal.

Residues of malathion on brinjal fruits were found to fall below the tolerance limit of 8 ppm in 24 hours. But a waiting period of 3 days was suggested (Lakshminarayana & Menon 1974). Jain & Gupta (1976) observed that it took actually 3 days for residues of malathion on the fruits to drop below the tolerance limit. Rajakannu et.al. (1976) found that a deposit of 3.5 ppm of endosulfan on brinjal fruits was reduced to 0.20 ppm in 10 days. A waiting period of 3 days was proposed for this. Carbaryl sprays at 0.1% concentration left an initial deposit of 18.2 ppm on fruits and this was reduced to levels below tolerance limit in 3 days. Washing removed the deposits from the fruits by 45 - 60%.

Cowpea.

When malathion was sprayed on cowpea plants twice at fortnightly intervals from the 60th day after sowing at 0.05 & 0.1% concentrations 18.0 and 32.5 ppm deposits respectively were detected on the pods and these were reduced to below the tolerance limit of 3 ppm in 1 and 5 days respectively (Fotedar et.al. 1976).

Srivastava & Sharma (1976) found that 0.2% and 0.3% sprays of carbaryl left deposits of 22.22 ppm and 37.77 ppm respectively on pods. It took 3 and 5 days respectively for the residues on pods to go below tolerance limits. Washing reduced the residues by 77.5 to 83.82%.

Studies of Pandey et.al. (1977) showed that two sprays of endosulfan 0.07% on cowpea at pod formation stage left deposits

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of 10.73 to 14.40 ppm on pods. This was reduced to 5 to 9 ppm at harvest. The insecticide was translocated into grains to the extent of 1.95 to 7.7 ppm. As 2 ppm was the tolerance limit only one application of endosulfan was recommended. Awasthi et.al. (1977) found that deposits of carbaryl on cowpea pods took 10.1 to 15.1 days for getting below tolerance limit level of 5 ppm. Grains did not contain the residues.

MATERIALS AND METHODS.

Determination of residue - mortality relations between insecticide residues on different vegetables and Drosophila melanogaster.

Relations (curves) between residues of insecticides in ppm and mortality in percentage of D.melanogaster (test insect) were worked out for each insecticide and different vegetables to serve as reference curves for determination of unknown residues on the vegetables. These were done as follows:-

Deposit of the insecticide was laid on the vegetable surface by dissolving the technical grade of the insecticide in acetone and spreading the solution on the surface by dropping from a pippette and allowing it to evaporate. The amount of the insecticide laid on the vegetable surface was adjusted so as to give a fixed ppm of deposit in relation to the weight of the vegetable. The quantity of deposit laid on the vegetable surface was fixed either equivalent to its tolerance limit or above it. After spreading the acetone solution of the insecticide on the vegetable surface it was allowed to dry and kept for 30 minutes. Then the insecticide deposit was extracted

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from the vegetable surface by washing with acetone of volume equivalent to the weight of the vegetable i.e. 1ml : 1g. Washing was done by pouring the extractant over the vegetable repeatedly for 5 times. The extract was then sieved through sodium sulphate to remove water contents, if any. This extract of the insecticide deposit was then diluted with blank acetone extracts of the vegetable to give 4 or 5 graded concentrations. One ml of the dilution was poured into rimless test-tube 2.5 x 20 cm and made to dry on the inside surface of the tube by rotating it. After the solution had completely dried the tube was kept under a fan for one to two hours for the fumes of the acetone to disappear. Unsexed adults of D.melanogaster were released into these tubes and closed with muslin cloth using rubber bands. The tubes were then kept at a temperature of 28 ± 2°C and mortality counts of the flies taken 8 hours after exposure.

An example of the above process is given below:-

Vegetable : Bhindi fruit

Insecticide : Endosulfan

Preparation of insecticide solution:

A. 100mg of insecticide + 10ml of acetone = 10mg/ml soln.

B. 1ml of A + 9ml acetone = 1mg/ml soln.

C. 1ml of B + 9ml acetone = 100 µg/ml soln.

D. 1ml of C + 9ml acetone = 10 ppm.

Weight of bhindi fruits : 65 g

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To give 1 ppm deposit 65 µg of the insecticide has to be laid on the fruit surface. This is done by taking 6.5 ml of solution D (10 ppm) and dropping it on the fruit spread over its entire surface and allowing to dry. After 30 minutes of drying the fruit is then washed 5 times with 65 ml of pure acetone in a beaker. This extract is then sieved through anhydrous sodium sulphate in a funnel using more acetone to wash down and bring up the filtrate to 65 ml.

Dilution of deposit extract:

A.	Extract of deposit	=	1 ppm
B.	5 ml A + 5ml blank acetone extract	=	0.5 ppm
C.	5 ml B + 5 ml ,,	=	0.25 ppm
D.	5 ml C + 5 ml ,,	=	0.125 ppm
E.	5 ml D + 5 ml ,,	=	0.625 ppm.

One ml of each dilution is taken in the test tube and rolled spreading the solution within the tube and drying to leave the dry film of the toxicant. Each dilution is replicated twice. Control consists of clean tubes. Adults of D.melanogaster raised on the artificial culture medium, 2 days old and numbering 15 to 20 are released into each tube and closed with muslin secured with a rubber band.

The mortality data were analysed by probit analysis method and regression equations calculated.

Determination of insecticide residues on vegetables.

The vegetables required for these studies were raised in flower pots in field cages. The near mature fruits or pods were sprayed with the insecticides (see Table 1 for the names of insecticides) at their field doses. Spraying was done with

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an atomiser and every fruit was sprayed individually to the run-off levels. The sprayed fruits were collected at random at fixed intervals (see the Tables) and the residues on them extracted with acetone as detailed above. One ml of the extract was evaporated within the rimless test-tubes for making the dry films of the extracts. Adults of D.melanogaster were exposed to the dry films of the extracts and mortalities of the flies recorded after 8 hours. All these procedures were exactly as described above for the residue - mortality relations. The percent mortality values were corrected for control mortality, transformed into probits substituted for Y in the concerned regression equation and the corresponding values of X calculated. The antilog of these values gave the concentrations in ppm of the insecticide residues on the vegetables.

Determination of the effect of washing on reduction of insecticide residues from vegetables.

The vegetable sprayed with the insecticide was collected on the 2nd day of application and washed in water. For washing the vegetable was put in a beaker or in a large measuring cylinder containing water and the water agitated for 2 minutes. The vegetable thus washed was dried under fan and extracted with acetone and the residues on it ascertained as detailed above. Residue determinations of unwashed sprayed vegetables were made for comparison.

Rearing of D.melanogaster.

The test insect D.melanogaster was reared on an artificial medium of the following composition:-

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Corn flour	75 g
Agar agar	25 g
Brown sugar	65 g
Yeast	3.5 g
Vitamin B	15-20 tablets
Propionic acid	2-4ml
Water	1000 ml

The rearings were done in broad mouthed cylindrical jars enclosed with muslin cloth held by rubber bands. The jars were kept in BOD incubator at a temperature of 26-28°C.

R E S U L T S.

RESIDUE-MORTALITY RELATIONS BETWEEN RESIDUES OF DIFFERENT INSECTICIDES ON DIFFERENT VEGETABLES AND D.MELANOGASTER.

The results of these determinations are given in Tables 1 to 4.

Table 1. Residue-mortality relations between residues of different insecticides on bhindi fruits and D.melanogaster.

Insecticide	Hetero-gengeity X^2	Regression Equation	LC 50 (ppm)	Fiducial limits (ppm)
Malathion	--	Y = 5.377X - 15.4041	0.6222	--
Fenitrothion	6.33	Y = 1.071X + 1.4034	0.2286	0.1429 0.6026
Methyl-parathion	6.614	Y = 3.3044X - 6.9503	0.4130	0.3446 0.5094
Fenthion	4.371	Y = 3.0437X - 4.7348	0.1578	0.1303 0.1888
Quinalphos	7.706	Y = 1.609X - 0.03576	0.2137	0.1574 0.3388
Carbaryl	3.2583	Y = 1.1911X + 3.2561	29.11	20.00 42.37
Endosulfan	0.0446	Y = 4.223X - 5.6538	0.3334	0.2665 0.3939
Phosalone	1.8915	Y = 1.2818X + 2.28839	5.181	3.546 7.586

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Table 2. Residue-mortality relations between residues of different insecticides on brinjal fruits and D.melanogaster.

Insecticide	Hetero-geneity. X^2	Regression Equation.	LC 50 (ppm)	Fiducial limits (ppm)
Malathion	3.367	Y = 4.233X - 10.498	0.4581	0.3987 0.5327
Fenitrothion	3.4015	Y = 5.9522X - 8.2693	0.1695	0.1490 0.1930
Methyl-Parathion	4.781	Y = 3.5632X - 6.154	0.1350	0.1110 0.1598
Fenthion	13.307	Y = 3.2108X - 6.2374	0.3161	0.2633 0.3851
Carbaryl	0.0425	Y = 0.0653X + 3.9618	38.82	20.07 75.04
Endosunfan	4.1628	Y = 3.399X - 4.1167	0.4812	0.3986 0.5812
Phosalone	6.1951	Y = 1.043X + 2.0840	6.252	3.886 10.060
Quinalphos	12.219	Y = 3.2818X - 5.18518	0.1269	0.1090 0.1505

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Table 3. Residue-mortality relations between residues of different insecticides on cowpea pods and D.melanogaster.

Insecticide	Hetcro-geneity. χ^2	Regression Equation.	LC 50 (ppm)	Fiducial limits (ppm)
Methyl Parathion	3.3244	Y = 1.110X + 1.8227	0.0724	0.0466) 0.1125)
Malathion	8.8723	Y = 1.6790X - 1.4268	0.6725	0.4709) 0.9607)
Quinalphos	1.9591	Y = 0.0895X + 2.2558	0.1162	0.0647) 0.2089)
Carbaryl	1.8158	Y = 1.1962X + 3.3408	24.38	16.55) 35.91)
Endosulfan	3.1469	Y = 3.3766X - 5.3016	1.124	0.9204) 1.3730)
Phosalone	1.158	Y = 1.2750X + 0.0418	3.715	2.441) 5.667)
Fenitrothion	1.3101	Y = 3.256X + 1.5090	0.118	0.1007) 0.1386)
Fenthion	2.5298	Y = 6.7342X + 3.2959	0.3634	0.3004) 0.4308)

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Table 4. Residue-mortality relations between residues of different insecticides on bitter gourd fruits and D.melanogaster

Insecticide	Hetero-geneity. X^2	Regression Equation	LC 50 (ppm)	Fiducial limits (ppm)
Methyl Parathion	1.886	Y = 3.1761X + 5.4036	0.2373	0.0388) 0.7698)
Carbaryl	0.0441	Y = 0.2392X + 2.5328	75.78	59.94) 97.77)
Endosulfan	1.2622	Y = 4.3384X + 3.6048	0.3895	0.3273) 0.4735)
Quinalphos	0.4592	Y = 2.6114X + 1.0256	0.0213	0.0089) 0.0343)
Fenthion	0.4203	Y = 3.5112X + 0.6281	0.2347	0.0283) 0.5864)

PERSISTENCE OF INSECTICIDE RESIDUES ON VEGETABLES.

Carbaryl.

Results are presented in Table 5.

Table 5. Residues of carbaryl (0.2% suspension) on vegetables at different intervals after application.

Intervals (days)	Residues in ppm on: Bhindi	Brinjal	Cowpea	Bittergourd
2	26.3	12.83	17.26	46.08
2 (washed)	1.2	ND	ND	22.17
4	5.7	1.53	1.85	84.50
8	6.1	ND	ND	130.60

It will be seen that the residues of carbaryl from a spray of 0.2% suspension persisting on all the vegetables on the 2nd day of application were to the extent of 12.83 to

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46.08 ppm all of which were higher than the tolerance limit of 10 ppm fixed for the toxicant. From the fourth day onwards the residues had deteriorated to levels below the tolerance limits on bhindi, brinjal and cowpea but not on bitter gourd fruits. On bitter gourd the insecticide residues persisted at high levels even on the 8th day after application. The increase in the residues observed on these fruits as days passed could not be explained. Washing of the treated fruits on the second day of treatment reduced the residues of carbaryl on them to very low levels in all the vegetables excepting bitter gourd. On bitter gourd also there was a reduction of residues due to washing to the extent of 52% the residue persisting on the fruits being 22.17 ppm which was higher than the tolerance limit.

Malathion.

Results are presented in Table 6.

Table 6. Residue of malathion (0.1% emulsion) on vegetables at different intervals after application.

Intervals (days)	Residues in ppm on : Bhindi	Brinjal	Cowpea.
2	3.14	0.16	0.13
2 (washed)	0.28	0.07	0.16
5	ND	0.05	ND

The residues of malathion remaining on the vegetables from 0.1% sprays of malathion were much below the tolerance limit of 3 ppm on brinjal and cowpea pods on the second day of application. On bhindi this residue was to the extent of 3.14 ppm which was slightly above the tolerance limit. The

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residues had gone down to significant levels on the 5th day of spraying on all the three vegetables. Washing on the second day in water removed the residue on bhindi considerably bringing it well below the tolerance limit.

Methyl Parathion.

Data on these determinations are given in Table 7.

Table 7. Residues of methyl parathion (0.05% emulsion) on vegetables at different intervals after application.

Intervals (days)	Residues in ppm on : Bhindi	Brinjal	Cowpea	Bitter gourd.
2	1.32	0.39	1.25	ND
2 (washed)	0.22	0.29	0.38	ND
4	0.21	ND	0.26	--
8	ND	ND	ND	--

The levels of residues of methyl parathion on bhindi and cowpea were above the tolerance limit of 1.0 ppm on the second day of application. On the fourth day of application the residue levels in both these were reduced to insignificant levels. On brinjal fruits the residue on the 2nd day of application was only 0.39 ppm which was much below the tolerance level. On bitter gourd fruits there was no detectable level of the residue on the second day of application. Washing the vegetables was effective in reducing the residues of methyl parathion considerabley and washing on the second day brought down the residues to safe levels on bhindi and cowpea.

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Fenitrothion.

Results of the residue determinations of fenitrothion from 0.05% sprays are given in Table 8.

Table 8. Residues of fenitrothion (0.05% emulsion) on vegetables at different intervals after application.

Intervals (days)	Residue in ppm on Bhindi	Brinjal	Cowpea
2	0.59	0.22	0.13
2 (washed)	0.50	ND	0.12
4	0.27	ND	0.09
7	ND	--	0.04

Residue of fenitrothion persisting on bhindi fruits after 2 days of application was 0.59 ppm which was higher than the tolerance level of 0.3 ppm. On the 4th day the residue had been reduced to 0.27 ppm which was just below the tolerance limit; on the 7th day there was no detectable level of the residue. On brinjal fruit and cowpea pods the residues persisting on the 2nd day of application were 0.22 and 0.13 ppm respectively and were below the tolerance limits. Washing on the 2nd day was not found to reduce the residues of fenitrothion to any significant level on bhindi and cowpea. So on bhindi washing could not bring down the residues to safe levels on the 2nd day.

Fenthion.

Results of residue determinations on vegetables of fenthion used as 0.05% sprays are given in Table 9.

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Table 9. Residues of fenthion (0.05% emulsion) on vegetables at different intervals after application.

Intervals (days)	Residues in ppm on : Bhindi	Brinjal	Cowpea	Bitter gourd
2	0.055	0.25	0.25	0.13
2 (washed)	0.04	0.13	0.22	0.08
4	--	--	0.16	ND
7	0.04	--	ND	--

It may be seen that the residues of fenthion left in the different vegetables on the second day of application were from 0.055 ppm on bhindi to 0.25 ppm on brinjal and cowpea. All these levels were below the tolerance level of 0.5 ppm fixed for the toxicant. There were also indications that the residues could be reduced by washing.

Quinalphos.

Results of residue determinations of quinalphos on vegetables when used as 0.05% sprays are presented in Table 10.

Table 10. Residues of quinalphos (0.05% emulsion) on vegetables at different intervals after application.

Intervals (days)	Residue in ppm on: Bhindi	Brinjal	Cowpea	Bitter gourd
2	0.83	0.34	0.23	0.009
2 (washed)	0.05	0.097	0.20	ND
4	--	0.195	0.015	0.013
7	0.01	0.17	0.014	ND

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The levels of residues of quinalphos were 0.83 and 0.34 ppm respectively on bhindi and brinjal fruits on the second day of insecticide application and these were higher than the tolerance limit of 0.25 ppm fixed for the toxicant. On cowpea the level was slightly below the tolerance level and on bitter gourd much below the safe level. On the fourth day of insecticide application the residue levels of the insecticide had come down to low and safe levels on bhindi and brinjal. Washing on the second day was effective in bringing down the residues to very low and safe levels.

Endosulfan.

Results of residue determinations of endosulfan used as 0.05% sprays on vegetables are given in Table 11.

Table 11. Residues of endosulfan (0.05% emulsion) on vegetables at different intervals after application.

Intervals (days)	Residues in ppm on : Bhindi	Brinjal	Cowpea	Bitter gourd
2	0.15	0.12	0.65	ND
2 (Washed)	ND	0.12	ND	ND
4	0.15	0.13	0.31	--
10	0.12	ND	ND	--

It will be seen that the residues of endosulfan on the vegetables on the second day of application ranging from non-detectable levels to 0.65 ppm were much below the tolerance limit of 2.0 ppm fixed for the toxicant on vegetables. Washing

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was effective in removing the residues on bhindi and cowpea but not on brinjal. The reduction of the existing residues on the vegetables was slow till fourth day; on the tenth day there was still residues on bhindi fruits while on the others there were no detectable residues.

Residues of Phosalone on Vegetables.

Residue determinations made of phosalone applied as 0.05% emulsion on bhindi, brinjal and cowpea showed that there were no detectable residues on these vegetables on the second day of application of the insecticide.

Residues of Insecticides on Sweet-potato tubers.

For determining the residues of insecticides which might be persisting on sweet potato tubers when used to control the sweet potato weevil a field experiment was conducted. Sweet potato was cultivated on raised circular mounds following the usual agronomic practices. The insecticides were applied to the mounds as drenches 30 days and 60 days after planting. The tubers were harvested on the 90th day and the external residues of insecticides on the tubers determined as in the case of other vegetables. Reference curves also had been prepared for each insecticide. None of the insecticides had left any detectable residues on the tubers. Hence the detailed data on the reference curve and residue determinations are not presented in this report.

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D I S C U S S I O N.

Assay of insecticide residues persisting on vegetables following application of toxicants was done in terms of the response of D.melanogaster to the residues. The response used was mortality and this was ascertained by exposing the test insects to dry films of the residues laid within the surface of test-tubes from the residue extracts in acetone. The response of the test insect was actually to a combination of the insecticide and acetone-soluble plant extracts. Hence it was considered necessary that in the formulation of the reference curve also the influence of the plant extracts, if any, was taken into account. It was to ensure this, that in the reference curve determinations of the response of the test insect to graded concentrations of the known residues, the insecticide was laid first on the vegetable surface and extracted with acetone. The dosage (residue) - mortality relations between the different insecticides and D.melanogaster are given in Tables 1 to 4 in terms of regression equation and LC 50 in each case.

One observation which has emerged is that the test insect responds differently to the same insecticide when laid and extracted on different vegetables. A comparison of the LC 50 values of the same insecticide extracted from different vegetables will show this. Such a comparison for the different insecticides is presented in Table 12. It is not possible to explain why this variation is due to with the available information.

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Table 12. LC 50 values of different insecticide residues to D.melanogaster on different vegetables.

Insecticide	LC 50 on: Bhindi	Brinjal	Cowpea	Bitter gourd
Malathion	0.6223	0.4581	0.6725	--
Fenitrothion	0.2286	0.1695	0.1180	--
Methyl parathion	0.4130	0.1350	0.0724	0.2373
Fenthion	0.1578	0.3161	0.3634	0.2347
Quinalphos	0.2137	0.1269	0.1162	0.0213
Carbaryl	29.11	38.82	24.38	75.78
Endosulfan	0.3334	0.4812	1.124	0.3895
Phosalone	5.181	6.252	3.71	--

Results of residue determinations of insecticides on the vegetables will help in fixing the waiting periods. Waiting period can be taken as the time required for the residues of insecticides on the vegetables to reach levels below the tolerance limits following the application of the insecticides. A consolidated statement of the time needed for the insecticide residues to fall below tolerance levels is given in Table 13.

On bhindi fruits residues of malathion are reduced to safe level in 5 days. The waiting periods reported by earlier workers vary considerably they being 3 hours (Jat et.al. 1973), zero hour (initial deposit below tolerance limit) (Joia et.al. 1974; Deshmukh & Singh, 1975) and 7 days (Dixit et.al. 1975).

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Table 13. Time needed for the insecticide residues to fall below tolerance limits on different vegetables.

Insecticide	Time in days needed for residues to fall below tolerance limits on : Bhindi	Brinjal	Cowpea	Bitter gourd
Malathion	5	2	2	-
Fenitrothion	4	2	2	-
Fenthion	2	2	2	2
Endosulfan	2	2	2	2
Carbaryl	4	4	4	More than 8
Quinalphos	4	4	2	2
Methyl parathion	4	2	4	2
Phosalone	2	2	2	2

Waiting period for fenthion on bhindi is 2 days in the present studies as against zero hour reported by Joia et.al. (1974). For endosulfan the waiting period of 2 days fixed compares well with zero hour of Singh et.al. (1974), Joia et.al. (1974) and Dixit et.al. (1975) and 3 days of Rajakannu et.al. (1976). A 6 day waiting period was, however, recommended by Nath et.al. (1974) for endosulfan. For carbaryl residues on bhindi a waiting period of 4 days is indicated here, the previous findings being 3 days (Raghuraj et.al. 1973 and Rajakannu et.al. 1976), 24 hours (Srivastava et.al. 1976) and zero hour (Deshmukh & Singh 1975). The residue determinations of fenitrothion, quinalphos, methyl parathion and phosalone on bhindi have been done for the first time and the waiting periods arrived at for them are 4, 4, 4 and 2 days respectively.

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On brinjal fruits waiting period proposed is 2 days for malathion. A 3 day waiting period has been recommended by Lakshminarayanan & Menon (1974) and Jain & Gupta (1976). For endosulfan a waiting period of 2 days is fixed as against 3 days proposed by Rajakannu et.al. (1976). For carbaryl the waiting period arrived at in the present studies on brinjal is 4 days while 3 days have been proposed by Rajakannu et.al. (1976). Waiting periods have been worked out for the first time for fenitrothion, fenthion, quinalphos, methyl parathion and phosalone on brinjal fruits and these are 2, 2, 4, 2 and 2 days respectively.

On cowpea pods 2 days form the waiting period for malathion in the present studies. Fotedar et.al.(1976) recommended 5 days. For carbaryl a period of 4 days is seen to be the waiting period as against 3 days reported by Srivastava & Sharma (1976) and 11 - 15 days reported by Awasthi et.al. (1977). Waiting periods have been recommended for the first time for fenitrothion, fenthion, endosulfan, quinalphos, methyl parathion and phosalone on cowpea pods and these are 2, 2, 2, 2, 4 and 2 days respectively.

On bitter gourd fruits waiting periods have been determined for fenthion, endosulfan, carbaryl, quinalphos, methyl parathion and phosalone for the first time. These waiting periods are 2, 2, more than 8, 2, 2 and 2 days respectively.

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In general washing of the vegetables on the 2nd day of insecticidal application has been seen to be effective in bringing down the residues to safe levels. Thus, residues of carbaryl have been removed and brought to insignificant levels by washing on bhindi, brinjal and cowpea pods but not on bitter gourd fruits. Effective removal of carbaryl residues from vegetables has been reported earlier by Deshmukh & Singh (1975), Krishniah et.al. (1975), Srivastava et.al. (1976) Rajakkanu et.al. (1976) and Strivastava and Sharma (1976).

Malathion and methyl parathion residues are reduced to safe levels by washing on bhindi, brinjal and cowpea. Fenitrothion residues can be effectively removed by washing from brinjal and cowpea but not from bhindi fruits. Quinalphos residues are removed effectively by washing from bhindi, brinjal, cowpea and bitter gourd. Endosulfan residues also can be removed similarly. Effective removal of endosulfan residues has been reported also by Nath et. al.(1974) and Rajakannu et. al. (1976).

The findings that phosalone does not show any detectable residues on the vegetables on the second day of application and that none of the insecticides under study leave any detectable residues on sweet potato tubers are significant findings.

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SECTION D.

S U M M A R Y.

Residue-mortality relations between insecticide residues on vegetables and adults of Drosophila melanogaster (test insect used in the bioassay) were worked out. The method used for these determinations is described. The insecticides used for these determinations were carbaryl, methyl parathion, malathion, fenthion, fenitrothion, quinalphos, phosalone and endosulfan. The vegetables used in these studies were fruits of bhindi, brinjal and bitter-gourd and cowpea pods. The data in each case was analysed by probit analysis method and regression equations worked out. These equations were used as reference equations for determination of unknown residues on the vegetables.

Residues of carbaryl, malathion, methyl parathion, fenitrothion, fenthion, quinalphos and endosulfan remaining on fruits of bhindi, brinjal and bitter gourd and cowpea pods were determined by bioassay as mentioned above at different intervals after application of the insecticides. The method used in these determinations is described.

The periods taken for the residues of the different insecticides on different vegetables when applied as sprays at field concentrations, to decrease to levels below the tolerance limits (waiting periods) were as follows:-

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For malathion, 5 days on bhindi, 2 days on brinjal and 2 days on cowpea pods. For fenitrothion, 4 days on bhindi and 2 days each on brinjal and cowpea. For fenthion, 2 days each on bhindi, brinjal, cowpea and bitter gourd. For endosulfan, 2 days each on bhindi, brinjal, cowpea and bitter gourd. For carbaryl 4 days each on bhindi, brinjal and cowpea and more than 8 days on bitter gourd. For quinalphos, 4 days each on bhindi and brinjal and 2 days each on cowpea and bitter gourd. For methyl parathion, 4 days each on bhindi and cowpea and 2 days each on brinjal and bitter gourd. For phosalone 2 days each on bhindi, brinjal, cowpea and bitter gourd.

Washing of the insecticide treated vegetables on the 2nd day of treatment was in general effective in removing the residues substantially. Washing was effective in bringing the residues below tolerance limits in the case of carbaryl on bhindi, brinjal and cowpea, malathion on bhindi, methyl parathion on bhindi and cowpea and quinalphos on bhindi and brinjal. Washing was not effective in removing carbaryl from bitter gourd and fenitrothion from bhindi.

SECTION E

REMARKS OF THE STANDING COMMITTEE AND ACTION TAKEN THEREON

....28.

SECTION F

RESULTS OF RESEARCHS THAT CAN BE EXPLOITED ON PILOT OR FIELD SCALE.

b) Results of researches of proved economic value that may be passed on to the extension workers for general adoption.

(i) Hazards of insecticide residues to human health form one of the important adverse side effects of insecticidal control of crop pests. An effective control of such hazards consists in fixing waiting periods for the different insecticides on different crops. Waiting period signifies the minimum period which should elapse for the residues of the insecticide on a crop to dissipate to levels below the tolerance limit of the insecticide. Based on the findings of the present studies waiting periods can be fixed as given below for the different insecticides and vegetables under the eco-climatic system existing in Kerala.

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Insecticide spray concentration	Vegetable	Waiting period in days.
Carbaryl 0.2%	Bhindi	4
	Brinjal	4
	Cowpea	4
	Bitter gourd	More than 8
Malathion 0.1%	Bhindi	5
	Brinjal	2
	Cowpea	2
Methyl parathion 0.05%	Bhindi	4
	Brinjal	2
	Cowpea	4
	Bitter gourd	2
Fenitrothion 0.05%	Bhindi	4
	Brinjal	2
	Cowpea	2
Fenthion 0.05%	Bhindi	2
	Brinjal	2
	Cowpea	2
	Bitter gourd	2
Quinalphos 0.05%	Bhindi	4
	Brinjal	4
	Cowpea	2
	Bitter gourd	2
Endosulfan 0.05%	Bhindi	2
	Brinjal	2
	Cowpea	2
	Bitter gourd	2
Phosalone 0.05%	Bhindi	2
	Brinjal	2
	Cowpea	2
	Bitter gourd	2

(ii) All the above eight insecticides can be used for the control of sweet potato weevil on the crop up to one month prior to harvesting without any risk of contamination of the tubers by the insecticide residues.

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(iii) Results have shown that in general washing the treated fruits in water is helpful in removing the insecticide residues to levels below tolerance limits. This information may be transmitted to cultivators so that they may wash the treated vegetables before being marketed.

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(M.R.G.K. Nair.)
Signature of Scientist.

Date: 7--7--1980.

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