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RESEARCH ARTICLE

Gas chromatography- residue analysis of Pesticide (Malathion) in field samples of two varieties (K-21 and DS-22) of tomato (*Lycopersicum esculentum* L.) grown in Gwalior region, M.P, India.

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Abstract

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The experiment was carried out at three different sites in Gwalior region namely Badagaon (rural), Bijauli (periurban) and Birla nagar (urban) on two commonly grown varieties of tomato in Gwalior region namely K-21 and DS-22. Recommended doses of malathion were applied. The experimental plots were maintained in triplicates for both the varieties at each site. Three samplings were done after 110 days of sowing, at an interval of every 20 days to 150 days of sowing. Malathion (insecticide) was sprayed at 50th day (flowering stage) and at 100th day (fruiting stage) from the date of sowing. Extraction of insecticide was carried out by Dichloromethane, Acetone, Hexane. Malathion residue was analyzed by using Gas Chromatograph (GC) (model-chemito, GC-1000) with ECD (electron capture detector). The residue level of malathion is observed and reported.

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Introduction

The geometric increase in the population has led to a considerable increase in allied activities especially agriculture. This resulted in an overall increase in consumption of pesticides in various activities. Improved agricultural practices and green revolution' has brought a substantial increase in consumption of pesticides in agriculture fields. They are widely used to destroy pests and weeds thereby increasing crop yield and reducing post harvest losses but due to their selective toxicity, biocidal activities and persistence in agricultural products (fruits and vegetables) and soil they can pose a dangerous threat to human health and environment. Pesticides are chemicals that are toxic to pests and insects even in very small amounts" and commonly used pesticides in agriculture include insecticides, weedicides, herbicides etc¹. For better yield and quality, insecticides are applied during the entire growth period and even at fruiting stage. However excessive application of pesticides causes bioaccumulation and biomagnification of pesticides which adversely effects the food chains. However, there is a gradual decline in the usage of insecticides worldwide but in India, insecticide residues will still continue to be an issue for at least another decade². Government and international organizations set the so called Maximum Residue Limit (MRL) in their legislation to monitor the level of pesticides in foods in order to minimize consumers intake. Food containing residues that fall within MRL are "toxically acceptable" exceeding the MRL limit can indicate the over use of pesticides which is not safe. Major portion of insecticide is consumed for the destruction of pests, but some portion of pesticide residues may still be present in agricultural products and soil, as their degradation may take time. A Pesticide decreases the biodiversity in soil and it has been found that the quality of soil is higher in the absence of pesticide with the additional effect of high water retention³. Statistics shows a 70 % increase in the risk of developing Parkinson's disease for individuals exposed to low levels of pesticides⁴ Most of the agricultural food products (fruits and vegetables) have been reported to test positive towards pesticide residue⁵⁻⁸. However little effort have been made to monitor pesticide level in vegetables, fruits, water and environment. Therefore monitoring of pesticides in agriculture and increasing public awareness for using less toxic pesticides and their effect on human health, needs an

urgent addressal thus in the present study we have documented the determination of malathion residues in 3 samples of two different varieties of tomatoes i.e K-21 and DS-22, grown at three different sampling sites by Gas chromatography.

1.1 Chemical structure of Pesticide : Malathion (organo phosphate) : IUPAC name:O,O-dimethyl dithiophosphate of diethyl mercaptosuccinate. Butanedioic acid, [(dimethoxyphosphinothioyl)thio]-, diethylester (Malathion)



Molecular weight: 330.36 g/mol, Appearance : Malathion is yellow to brown liquid with a skunk or garlic like odour.

Boiling point : 155-157°C, Flash point : 163°C, Vapor pressure1.78x10⁻⁴mm Hg at 25°C, Solubility : in water 130 mg/l at 20°C, readily missible with alcohol, ester, ketone, ethers and aromatics. It has limited solubility in paraffinic hydrocarbons.

Gwalior has a subtropical climate with very hot summers, but in winter months it is usually temperate and for short period extremely cold. The maximum temperature goes up to 44° C in summer where as the minimum goes down as low as 1-4°C in the month of December. The average rain in the district is about 850 mm/annum.

1. Materials and methods :

The organic solvents used were of AR grade and purchased from merck. Anhydrous sodium sulphate (AR), used for residue extraction has maintained at 200°C overnight and kept in air tight container. The pesticide was purchased from local pesticide market from Gwalior (M.P)

2.1 Selection of site

The cropping season of tomatoes in Gwalior region is between September to February. Tomatoes were grown at three different sites Badagaon, Bijauli, and Birlanagar at Gwalior, because these sites are generally used for growing tomatoes by the farmers. Bijauli is a 'rural site' (located in rural area), Badagaon is a 'periurban site' and Birlanagar is an 'urban site' (located near urban settlement).

During cropping season, application of fertilizers, irrigation and doses of insecticides were done as recommended. All other farming practices were same, for all three sites.

2.2 Selection of varieties

Two varieties of tomato namely K-21 and DS-22 are widely used in Gwalior region. They have been selected after intensive field surveys for the experimental purpose.

2.3 Field layout

Plots of 1m x 1m in triplicates were maintained along with control plot for each variety, with random replicate design. The plotting was such that the impact of insecticides was observed separately on both varieties of tomatoes. Control plots were also maintained for both the varieties at each site.

2.4 Sowing

Between 25 Aug-2008 and 25 Feb-2009.

2.5 Dosage rate

Foliar application of Malathion 50 EC at the rate of 0.02%, twice at an interval of 50 days from the date of sowing i.e. 50 day (14 Oct) and 100 day (3 Dec) as recommended.

2.6 Sampling method

Sampling was done by taking about 1 kg sample randomly in air tight bags packed with tags having sample ID (variety, sampling number etc). During handling of

samples, care was taken not to remove surface residues. Total three samplings have been done at every 20 days interval from the date of sowing i.e.

th	th	
13 Dec 2008	110 day	I Sampling
nd	th	
2 January 2009	130 day	II Sampling
nd	th	
22 January 2009	150 day	III Sampling

2.7 Sample preparation

Sample extracts of fresh fruits were prepared for micro extraction technique including pretreatment and clean up step using different mixtures. The methodology adopted for preparation of sample extract as well as cleaning was done according to the reported methods. Samples were analyzed on Gas Chromatograph (GC). (Model- chemito, GC-1000). Detector used was electron capture detector (ECD) with capillary column.

2.8 Estimation

The extracts were analyzed on GC (GC 1000, Chemito) with an Electron Capture Detector (ECD). A BP X5, 30 m X 0.32 mm id, capillary column was used in combination with oven temperature program, initial temperature 100° C, then heated to a final temperature of 290° C. The injector temperature was at 220° C and the detector temperature was at 320° C. Nitrogen gas was used as carrier gas with a gas flow at 3 ml/min.

3. Results and Discussion

The three samples (I, II and III) obtained from different areas of gwalior region namely Bijauli (rural), Badagaon (sub urban) and Birlanagar (urban) for both the varieties of tomato i.e K-21 and DS-22, gave the following results, when analyzed through a gas chromatograph. The response of malathion in village bijauli, a rural area could be summarized as:

The Standard peak for malathion was observed through GC and is shown in Fig 1.

For K-21 variety, at the time of I sampling, the amount of malathion was high, which degraded very fast at the time of second sampling such that the % area reduces to 2.7 from 18.8 in case of I sampling. However at the time of final sampling (III), the % area suddenly increased to a very high level (24.6%), as can be seen in the gas chromatogram (Fig 2-4).

In case of DS-22 variety, the malathion during I sampling was higher (21.6%) as compared to K-21 (18.8%) and the trend was same i.e during the II sampling, it reduced to 4.2 and again increased to 6.2 at the time of final sampling. This response of malathion was observed more in K-21 variety as compared to DS-22 variety. This erratic trend for the amount of malathion in both the varieties was because of the fact that the plots for K-21 was very close to the irrigation canals (local earthen surface canals) which carried the pesticide from adjoining fields to the main sample plot. As a result, the amount of malathion at the time of III sampling was high (Fig 5-7).

Thus for the K-21 plots the % area enhanced from 2.7 to 24.6 during final sampling where as, DS-22 variety plots were away from the irrigation canals. As K-21 plots were just adjacent to the earthen canals, there response during III sampling enhanced the % area from 2.7 to 24.6, whereas the DS-22 variety plots were away from the irrigation canals and therefore enhancement was less.

The rapid decline in the % area of Malathion during II sampling for both the varieties K-21 and DS-22, could also be because of the fact that in between I and II sampling i.e. 110th and 130th day, some amount of rainfall was observed in the sampling site. It has been reported that approximately up to 70% of the Malathion is washed off, during washing by water¹².

The second site i.e. Badagaon is a periurban area and approximately 10 Km away from the city. The increasing trend of Malathion for both the varieties at the site Badagaon, was because of the fact that the site is in the periurban area and several allied activities may add to the increase in the % of Malathion. Sporadic showers four days before I sampling were observed at the sampling site, which must have resulted in the lowest % area of Malathion during I sampling. Also the irrigation water from the adjacent fields (Brinjal, wheat), could have enhanced the level of Malathion considerably during II and III sampling (Fig 8-13) The third site i.e. Birla Nagar is an urban site.

The % area of Malathion for I sampling was highest for both the varieties. The rapid decline in the % area during II sampling, for both the varieties, could be because of the fact that in between I and II sampling i.e. 110th and 130th day, sporadic showers were observed in the sampling site. It has been reported that approximately up to 70% of the Malathion is washed off, during washing by water12. However, the increase in value again for both the varieties during III sampling could be because of the change in the sink-source relationship of the plant (as this part of cropping season could be called as fruiting and ripening stage)

(Fig 14-19). GC analysis of control samples for both the variety of tomato are also shown (Fig 20-21)



Result Table	(Uncal - standard	- malathion -	17-Mar-2009 (001)
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	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.720	752.370	68.253	18.9	29.6
2	2.277	409.213	18.351	10.3	7.9
3	10.800	2824.911	144.254	70.9	62.5
	Total	3986.494	230.858	100.0	100.0

Fig. 1 : Standard peak for malathion (Retention time 10.800 minutes) obtained from GC



Result Table	(Uncal - K-21	M I - bijaul	ıli - 18-Mar-2009	001)
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	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.683	319.586	53.127	35.2	43.9
2	10.580	171.240	26.286	18.8	21.7
3	24.177	418.079	41.538	46.0	34.3
	Total	908.906	120.950	100.0	100.0

Fig. 2 : Chromotogram for malathion during I sampling at Bijauli (Rural site) for K-21 variety of tomato.



Result Table ('Uncal - K-21_	M_II - Bijauli	- 06-Feb-2009 001)
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	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.677	730.456	94.269	49.7	77.0
2	10.530	39.126	4.991	2.7	4.1
3	24.110	211.777	17.800	14.4	14.5
4	26.200	487.987	5.354	33.2	4.4
	Total	1469.346	122.413	100.0	100.0

Fig. 3 : Chromotogram for malathion during II sampling at Bijauli (Rural site) for K- 21 variety of tomato.



Result Table (Uncal - K-21_M_III - bijauli - 12-Feb-2009 001)

	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.703	597.002	77.069	49.2	63.3
2	10.640	298.705	23.420	24.6	19.2
3	24.273	239.074	20.738	19.7	17.0
4	35.067	79.557	0.602	6.6	0.5
	Total	1214.339	121.829	100.0	100.0

Fig. 4 : Chromotogram for malathion during III sampling at Bijauli (Rural site) for K- 21 variety of tomato.



Result Table (Uncar - DS-ZZ IVI T - Dilauli - To-IVIAI-2009	-22 M T-Dijauli - 18-Mar-2009 002)
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	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.723	994.999	113.227	50.9	64.4
2	10.600	422.949	10.721	21.6	6.1
3	24.190	535.795	51.985	27.4	29.5
	Total	1953.743	175.933	100.0	100.0

Fig. 5 : Chromotogram for malathion during I sampling at Bijauli (Rural site) for DS-22 variety of tomato.



Result Table (Uncal - DS-22_M_II - Bijauli - 07-Feb-2009 001)

	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.680	759.512	98.026	61.5	65.5
2	6.390	117.717	16.255	9.5	10.9
3	10.510	52.164	5.454	4.2	3.6
4	24.113	305.031	29.823	24.7	19.9
	Total	1234.425	149.558	100.0	100.0

Fig. 6 : Chromotogram for malathion during II sampling at Bijauli (Rural site) for DS-22 variety of tomato.



Result Table (Uncal - DS-22_M_III - Bijauli - 16-Feb-2009 001)

	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.693	738.877	99.552	58.4	69.3
2	2.197	14.645	2.089	1.2	1.5
3	10.657	78.743	9.153	6.2	6.4
4	22.950	70.163	1.220	5.5	0.8
5	24.303	362.021	31.545	28.6	22.0
	Total	1264.449	143.559	100.0	100.0

Fig. 7 : Chromotogram for malathion during III sampling at Bijauli (Rural site) for	DS-22 variety of
tomato.	

Table 1: Retention time (in minutes) and Area (%) of Malathion peak for K-21 varietyof Tomato atBijauli (rural site), Gwalior.

Sampling	I	п	Ш
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Retention time (minutes)	10.580	10.530	10.640
Area (%)	18.8	2.7	24.6



Graph 1 : % area of Malathion peak for K-21 variety of Tomato at Bijauli (Rural site), Gwalior.

Table 2: Retention time (in minutes) and Area (%) of Malathion peak for DS-22	variety of
Tomato at Bijauli (rural site), Gwalior.	

Sampling	I	П	III
Retention time (minutes)	Retention time (minutes) 10.600		10.657
Area (%)	21.6	4.2	6.2



Graph 2: % area of Malathion peak for DS-22 variety of Tomato at Bijauli (Rural site), Gwalior



	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.700	1155.344	113.610	75.4	67.0
2	10.580	148.490	25.048	9.7	14.8
3	24.167	227.621	30.814	14.9	18.2
******	Total	1531.455	169.472	100.0	100.0

Result Table (Uncal - K-21 M I - badagaon - 18-Mar-2009 001)





	Result Table (Uncal - K-21_M_II - Badagaon - 07-Feb-2009 001)								
	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]				
1	1.677	645.413	92.387	40.9	52.5				
2	10.510	708.976	59.998	45.0	34.1				
3	24.100	222.839	23.640	14.1	13.4				
	Total	1577.228	176.025	100.0	100.0				

Result Table	(Uncal - K-2	1_M_11 -	Badagaon	- 07-Feb-2009	001)
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Fig. 9 : Chromatogram for malathion during II Sampling at Badagaon (Peri urban site) for K-21 variety of tomato.



Result Table	(Uncal - K-21	_M_III - badagaon -	10-Feb-2009 001)
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Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1.690	458.489	68.306	20.6	32.6
10.817	1632.859	126.610	73.5	60.5
24.400	126.307	13.741	5.7	6.6
40.057	3.516	0.670	0.2	0.3
Total	2221.171	209.327	100.0	100.0
	Reten. Time [min] 1.690 10.817 24.400 40.057 Total	Reten. Time [min] Area [mV.s] 1.690 458.489 10.817 1632.859 24.400 126.307 40.057 3.516 Total 2221.171	Reten. Time [min] Area [mV.s] Height [mV] 1.690 458.489 68.306 10.817 1632.859 126.610 24.400 126.307 13.741 40.057 3.516 0.670 Total 2221.171 209.327	Reten. Time [min] Area [mV.s] Height [mV] Area [%] 1.690 458.489 68.306 20.6 10.817 1632.859 126.610 73.5 24.400 126.307 13.741 5.7 40.057 3.516 0.670 0.2 Total 2221.171 209.327 100.0

site) for K-21

Fig. 10 : Chromatogram for malathion during III Sampling at Badagaon (Peri urban variety of tomato.

3/17/2009 4:33 PM Chromatogram C:\\ris32 Lite\WORK1\DATA\badagaon - DS-22_M_I - 30-Jan-2009 001.PRM Page 1 of 1 SOS in Botany Jiwaji University Gwalior Chromatogram Info: : C:\lris32 Lite\WORK1\DATA\badagaon - DS-22_M_I -30-Jan-2009 001.PRM File Name File Created : 1/30/2009 1:30:11 PM Origin : Acquired Acquired Date : 1/30/2009 1:30:11 PM Project : c:\iris32 lite\Projects\Work1.PRJ Ву : FOOD TECHNOLOGY DEPARTMENT, JU, GWALIOR Sample Info: Sample ID : badagaon Amount : 1 Sample : DS-22/M/I ISTD Amount : 0 Inj. Volume [ml] : 1 Dilution : 1 [mV]. badagaon - DS-22_M_I - 30-Jan-2009 001 80-667 60 Voltage 24.137 40-10.543 20 0 0 10 20 30 40 [min.] Time

Kesult Table (Uncal - badagaon - DS-22_W_T - 30-Ja	11-2009	001)	ļ
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	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.667	530.910	57.608	85.3	85.3
2	10.543	18.451	3.322	3.0	4.9
3	24.137	73.390	6.576	11.8	9.7
	Total	622.751	67.506	100.0	100.0

Fig. 11 : Chromatogram for malathion during I Sampling at Badagaon (Peri urban site) for DS-22 variety of tomato.



Result	Table	(Uncal - DS-22	MII.	 badagaon - 	06-Feb-2009	001)
				-		

	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.623	510.510	82.105	49.1	70.2
2	10.473	222.528	20.475	21.4	17.5
3	24.067	112.814	10.039	10.8	8.6
4	25.337	0.135	0.144	1.294e-02	0.1
5	38.923	194.638	4.155	18.7	3.6
	Total	1040.625	116.918	100.0	100.0
the second se	and the second se	the second se	the second se	the second se	the second se

Fig. 12 : Chromatogram for malathion during II Sampling at Badagaon (Peri urban variety of tomato. site) for DS-22



Result Table (Uncal - DS-22_M_III - badagaon - 12-Feb-2009 001)

	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.700	1074.131	97.052	29.9	35.5
2	10.780	2273.529	155.118	63.4	56.7
3	24.323	239.381	21.409	6.7	7.8
	Total	3587.041	273.578	100.0	100.0

Fig. 13 : Chromatogram for malathion during III Sampling at Badagaon (Peri urban site) for DS-22 variety of tomato.

Sampling	I	п	ш
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Retention time (minutes)	10.580	10.510	10.817
Area (%)	9.7	45.0	73.5

Table 3: Retention time (in minutes) and Area (%) of Malathion peak for K-21Tomato at Badagaon (periurban site), Gwalior.

variety of



Graph 3 : % area of Malathion peak for K-21 variety of Tomato at Badagaon (Peri Urban site), Gwalior

Table 4: Retention time (in minutes) and Area (%) of Malathion peak for DS-22 varietyof Tomato atBadagaon (peri urban site), Gwalior.of Tomato at

Sampling	I	п	Ш
Retention time (minutes)	10.543	10.473	10.780
Area (%)	3.0	21.4	63.4



Graph 4 : % area of Malathion peak for DS-22 variety of Tomato at Badagaon (Peri Gwalior

Urban site),



result Table (Ofical - bina nagal - rest_i_wi_i - 05-reb-2009 00	Uncal - Birla nagar - K-21_M_I - 03-Feb	5-2009 002
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	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.673	1031.739	101.663	32.2	39.3
2	5.310	163.047	24.520	5.1	9.5
3	10.583	1842.589	114.320	57.5	44.2
4	24.157	169.193	18.326	5.3	7.1
************	Total	3206.567	258.828	100.0	100.0

Fig. 14 : Chromatogram for malathion during I Sampling at Birla Nagar (urban site) for K-21 variety of tomato.



Result Table (Uncal - K-21	M 11 -	Birlanagar	- 07-Feb	-2009 ()01)
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	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.637	674.252	92.746	52.4	62.1
2	10.453	347.187	33.823	27.0	22.6
3	24.043	265.819	22.794	20.7	15.3
	Total	1287.258	149.363	100.0	100.0

Fig. 15 : Chromatogram for malathion during II Sampling at Birla Nagar (urban site)	for K-21
variety of tomato.	



	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.687	496.979	74.714	44.3	48.3
2	10.683	623.646	80.027	55.7	51.7
	Total	1120.625	154.742	100.0	100.0

Result Table (Uncal - K-21_M_III - birlanagar - 12-Feb-2009 001)

Fig. 16 : Chromatogram for malathion during III Sampling at Birla Nagar (urban site)	for K-21
variety of tomato.	



Result Table	(Uncal - Birla na	gar - DS-22_M_	I - 03-Feb-2009 001)
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	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	0.233	3.555	0.468	0.1	0.2
2	1.633	364.198	64.887	14.1	29.8
3	5.287	91.026	13.480	3.5	6.2
4	10.623	1993.204	126.917	76.9	58.3
5	24.097	140.072	11.999	5.4	5.5
	Total	2592.055	217.750	100.0	100.0

Fig. 17 : Chromatogram for malathion during I Sampling at Birla Nagar (urban site)for DS-22variety of tomato.



Result Table (Uncal - D	S-22 A	1 11 - I	Birlanagar -	06-F	eb-2009	001)
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	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.663	1098.055	103.522	70.3	73.3
2	10.500	190.151	8.033	12.2	5.7
3	24.117	274.289	29.668	17.6	21.0
	Total	1562.495	141.224	100.0	100.0

Fig. 18 : Chromatogram for malathion during II Sampling at Birla Nagar (urban site)	for DS-22
variety of tomato.	



Result Table	(Uncal - I	DS-22 /	N III	- Birlanagar -	16	Feb-2009 (201)
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	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.703	815.493	96.799	24.7	34.8
2	10.773	2312.859	160.352	70.0	57.7
3	24.323	177.605	20.764	5.4	7.5
	Total	3305.957	277.914	100.0	100.0

Fig. 19 : Chromatogram for malathion during III Sampling at Birla Nagar (urban site)	for DS-22
variety of tomato.	

Table 5: Retention time (in minutes) and Area (%) of Malathion peak for K-21 varietyof Tomato atBirlanagar (urban site), Gwalior.

	Sampling	I	П	Ш
	Retention time (minutes)	10.583	10.453	10.683
ea	Area (%)	57.5	27.0	55.7
% Ar (

Graph 5 : % area of Malathion peak for K-21 variety of Tomato at Birla Nagar (Urban site), Gwalior

Table. 6: Retention time (in minutes) and Area (%) of Malathion peak for DS-22 variety	of Tomato at
Birlanagar (urban site), Gwalior.	

Sampling	I	П	ш
Retention time (minutes)	10.623	10.500	10.773
Area (%)	76.9	12.2	70.0



Graph 6 : % area of Malathion peak for DS-22 variety of Tomato at Birla Nagar Gwalior





Result Table	(Uncal - OPContro	I Sample - K-25_I	- 03-Oct-2008 001)
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	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.790	1325.786	75.072	98.4	97.0
2	4.933	21.941	2.316	1.6	3.0
	Total	1347.727	77.389	100.0	100.0

Fig. 20 : Chromatogram for malathion for control sample of K-21 variety of tomato.



	Reten. Time [min]	Area [mV.s]	Height [mV]	Area [%]	Height [%]
1	1.810	1072.975	80.323	100.0	100.0

80.323

Fig. 21 : Chromatogram for malathion for control sample of DS-22 variety of tomato.

1072.975

4. Conclusion

Total

The rural site Bijauli, showed an erratic trend of Malathion with the % area of K-21 recording a massive increase and DS-22 variety showing less increase during III sampling. The % area of malathion for both the varieties reduced tremendously for the rural site, Bijauli. (Graph 1-3, Table 1-3)

Similarly the periurban site (Badagaon) projected a phenomenal increase with approximately the same trend during all the three samplings. (Graph 4-6, Table 4-6)

100.0

100.0

Similarly, the urban site (Birla Nagar) again projected the same trend as for the rural site i.e. Bijauli with the % area going down during the II sampling and again increasing at the time of III sampling. (Graph 7-9, Table 7-9).

The given piece of work will help the scientists to determine MRL values for Gwalior region. Moreover the judicious use of this pesticide can be advised to the farmers, so that the harmful effects on human health can be reduced.

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