

Original Research Article

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Persistence of Acephate, and Chlorpyrifos and Decontamination by Various Culinary Practices in Cucumber

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ABSTRACT

The research was carried out to determine the persistence of acephate and chlorpyrifos on cucumber crop and soil along with the effect of decontamination processes. The initial deposits due to single dose of acephate (560 g a.i. ha⁻¹) and chlorpyrifos (300 g a.i. ha⁻¹), were 0.640 and 0.980 mg kg⁻¹, respectively in cucumber fruits. However, at double dose the initial deposits were 1.123 and 1.860 mg kg⁻¹ for respective insecticides. Acephate and chlorpyrifos residues persisted in cucumber fruits upto 5 and 7 days at single dose and 7 and 10 days at double dose, respectively. The residues of acephate and chlorpyrifos on fruits reduced to half in less than 2 days with safe waiting periods of 9 and 10 days, respectively. Among various decontamination processes, peeling was found most effective which provided upto 91.36 per cent relief from chlorpyrifos and 71.07 per cent in case of acephate.

Keywords

Vitamin C,
thiamine, niacin,
iron, phosphorus

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Introduction

Cucumber (*Cucumis sativus* L.) is one of the important cucurbitaceous annual creeping vine of Asiatic origin. It can be successfully grown in tropical, sub-tropical and temperate regions of the world. Fresh cucumber is a source of vitamin C, thiamine, niacin, iron, phosphorus, calcium and dietary fiber (Aslam *et al.*, 2008). Cucumber fruits are mostly eaten raw as a salad, containing 95 per cent of water, making

them an ideal hydrating cooling food. The seeds of cucumber are used in ayurvedic preparation and raw fruits are also used in cosmetic preparation (Hatwal *et al.*, 2015).

Cucumber suffers major quantitative and qualitative loss in production due to major pests like spider mite (*Tetranychus cucurbitae*), aphid (*Aphis gossypii*), red pumpkin beetle (*Raphidophora foveicollis*), jassid (*Amrasca* sp.), fruit fly (*Bactrocera*

cucurbitae and *B. tau*) and green house white fly (*Trialeurodes vaporariorum*) (Sharma *et al.*, 2016). In India, Central Insecticide Board and Registration Committee (CIBRC) has recommended trichlorofon and dichlorvos against red pumpkin beetle on cucurbits.

Vegetables consumes 14% of the total pesticides used in India, in which the share of different types of pesticides in Indian agriculture market shows that organophosphorus (50%) ranked first, followed by pyrethroids (19%), organochlorines (18%), carbamates (4%) and biopesticides (1%) (Dhaliwal and Singh, 2000).

To combat the various insect pests in the field, the farmers go for rampant abuse of insecticides either by increasing the dosage or number of sprays of recommended pesticides or even using non-approved insecticides. Surveys carried out by different institutions spread throughout the nation indicated that 50-70% of total vegetables are contaminated with pesticide residues (Karanth, 2002). It is well recognized that there are risks attached to the consumption of pesticides treated crops because of the presence of residues on them. Therefore, the national recommendation of a pesticide requires that it must not only provide an effective control of pests but at the same time its residues on the commodity must also be toxicologically acceptable.

Therefore in the year 2005, the Department of Agriculture and Co-operation, Government of India had started a project "Monitoring of Pesticides Residues at National Level" to monitor the presence of residue of pesticides from market samples of fruits and vegetables. A recent data generated under this project revealed the presence of residues of some organophosphate insecticides like acephate and chlorpyrifos on cucumber which are not otherwise approved by CIBRC on any cucurbits.

Materials and Methods

The experiment was carried out in the Department of Entomology, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) during the year 2016 in randomized block design (RBD). The formulations of acephate (TKS-Ace 75SP) and chlorpyrifos (Chlorguard were purchased from local vendors of Solan. The selection of the insecticides were based on the highest usages by farmers on vegetables.

Field layout

The seeds of cucumber variety K-75 were sown at a planting distance of 125cm \times 60cm and plot size 3m \times 3m as per standard packages of practices. The cucumber crop was sprayed twice using Knapsack sprayer fitted with solid cone nozzle at 10 days interval of fruit development stage. Insecticides were sprayed on cucumber crop at the recommended dose (X) 560 g a.i. ha⁻¹ and 300 g a.i. ha⁻¹ and double the recommended dose (2X) 1120 g a.i. ha⁻¹ and 600 g a.i. ha⁻¹ for acephate and chlorpyrifos, respectively.

Both fruits and foliage of the plants were thoroughly covered with spray fluid to run-off stage. Spray was done on a clear day, when there was a minimum wind and all the necessary precautions were taken to avoid drifting of insecticides to adjoining plots. Also, spraying of lower concentration of insecticide prior to their respective higher concentration was considered.

The sprayer and measuring cylinder were washed thoroughly after each spray to avoid the carryover of insecticide from one treatment to another. The untreated plots were sprayed with water only and each treatment was replicate thrice. After the second spray, fruit samples (1 kg) from each replication were collected at 0 (2 hours after spray), 1, 3,

5, 7 and 10 days interval. Fruit samples collected at 1, 3 and 5 days interval were also processed for insecticide decontamination following different culinary practices. Also, soil samples (1 kg) from the sprayed field were drawn at 0, 3, 7 and 10 days interval for analysis. Soil samples were collected randomly from treatment and control plots from depth ranging from 0-25 cm. The samples were packed in polyethylene bags, labeled well. The average minimum and maximum temperature were recorded 20.56°C and 27.31° C and rainfall and relative humidity were 274.40 mm and 82.28 %.

Laboratory analysis

Sampling

Fruit samples were chopped into small pieces and mixed thoroughly. After quartering, a representative 500 g sample was taken in high volume homogenizer (Blixer® 6 V. V, France) for homogenization at a high speed to get the fine homogenate without any large particles or segregated material. Whereas, soil samples were put into plastic containers and allowed to shade dry at room temperature in the laboratory. The air dried samples were desegregated manually using a pestle and a marble mortar, passed through a brass soil sieve No. 20 mm and mixed thoroughly to achieve homogeneity.

Extraction of residues

Homogenized 15 g sample was taken in 50 ml polypropylene centrifuge tube containing 30 ml acetonitrile. Sample homogenized at 15000 rpm for 3 minutes using low volume high speed homogenizer (Heidolph, Germany). Then 10 g sodium chloride (NaCl) was added, shaken tube at 50 rpm for 3 minutes with Rotospin (Tarson Products Pvt. Ltd) and centrifuged at 2500 rpm for 3 minutes in eppendorf centrifuge (Eppendorf India Ltd.) to

separate the organic layer. The top organic layer of about 15 ml was taken into the 50 ml polypropylene centrifuge tube containing 10 g anhydrous sodium sulphate (Na_2SO_4) to remove the moisture content. For soil, 10 g sieved ground dry soil sample was taken in a 50 mL polypropylene centrifuge tube, to which 20 mL acetonitrile was added and allowed for shaking up to 1 minute using a Rotospin shaker.

Dispersive solid phase cleanup

After removing moisture content, 6 ml of extract was taken in to 15 ml polypropylene centrifuge tube, containing 400 mg PSA (Primary Secondary Amines) and 1150 mg anhydrous magnesium sulphate (MgSO_4). The sample tube was capped, shaken for 3 minutes at 50 rpm in Rotospin mixer and then centrifuged for 10 minutes at 2500 rpm. The extract of about 4 ml was transferred into test tubes and evaporated to dryness in the TurboVap® at 45°C in the presence of air current. In case of soil, add 4 g of anhydrous magnesium sulphate and 1 g of sodium chloride and centrifuged at 3300 rpm for 3 minutes. After centrifugation, 10 mL of supernatant was taken in another centrifuge tube of 15 mL containing 1.5 g of magnesium sulphate and 0.250 g of PSA, thereafter allowed for 3 minutes shaking. After shaking, the tube was sonicated (PCI India Pvt. Ltd.) for 3 minutes and then centrifuged for 10 minute at 4400 rpm.

From this tube, 4 mL aliquot of the supernatant was taken in a turbo tube and evaporated to dryness in presence of air current at 45° C. Reconstituted the volume with n-hexane (3 ml for fruits and 2 ml for soil) and injected 1µl into gas chromatograph (GC) equipped with mass spectrometer (MS) for acephate and flame photometric detector (FPD) for chlorpyrifos.

Decontamination

Cucumber fruit samples collected from each replication at 1, 3 and 5 days after the application of recommended dose, were processed with common household practices *viz.* tap water washing (fruits were rubbed and washed under tap water for 2 minutes and then dried in shade), vinegar dipping (fruits were dipped in 5 per cent acetic acid for 5 minutes and then analysed after shade drying) saline water (samples were dipped in water containing 2% NaCl for 5 minutes, taken out and shade dried), lukewarm water (treated fruit samples were dipped in lukewarm water (35-40° C) for 5 minutes) and peeling (fruits were peeled and then subjected to further analysis). The samples were then analyzed for insecticide residues by employing QuEChERS method as described above.

Instrumentation

Estimation and confirmation by GC-MS

The estimation of acephate and methamidophos was done by gas chromatograph mass spectrometer (GC-MS). The extracts were analyzed on SHIMADZU GC 2010 equipped with GC-MS. Helium was used as a carrier gas with a flow rate of 1 mL min⁻¹. The GC-MS operating conditions were: oven initial temperature was 80° C and held for 3 min, ramped 20° C min⁻¹ to 180° C and held for 4 min, then again raised to 280° at the rate of 30° C min⁻¹, held for 5 min; injector temperature, interface temperature and ion source temperature were 250 °C, 280 °C and 200 °C, respectively. Injection volume was 1 µL. Detector voltage was maintained at 1.0 KV. The compounds were identified in selective ions monitoring mode based on m/z ratio. Under these operating conditions, the retention time of acephate and methamidophos were found to be 8.851 and 7.213 min, respectively. The limit of quantification of

acephate and methamidophos was found to be 0.05 mg kg⁻¹.

Estimation and confirmation by GC-FPD

Chlorpyrifos was estimated by gas chromatograph flame photometric detector (GC-FPD). Nitrogen was used as a carrier gas and other gases used were Hydrogen and Zero air with a flow rate of 80.0 mL min⁻¹ and 120.0 mL min⁻¹. The GC-FPD operating conditions were as follows: oven initial temperature was 170° C and held for 5 min, ramped 20° C min⁻¹ to 250° C and held for 10 min and finally raised to 280° at the rate of 4° C min⁻¹, held for 10 min; injection port and detector temperature were 300 °C and 250 °C, respectively. Injection volume was 1 µL. Under these operating conditions, the retention time of chlorpyrifos was found to be 10.301 min. The limit of quantification was found to be 0.05 mg kg⁻¹.

Results and Discussion

Method validation

It is a confirmation through objective evidence that a method is fit for the intended purpose (Anonymous, 2015). The objective of any analytical measurement is to obtain consistent, reliable and accurate data. Acephate and its metabolite and chlorpyrifos gave good linear response at all proportionate concentrations with correlation coefficients (R²). Average recoveries and relative standard deviations of pesticide are summarized in Table 1.

Recovery studies

Data presented in Table 1 depicts reliability of analytical method tested by spiking of untreated cucumber fruits and soil samples at five fortification levels *viz.* 0.05, 0.10, 0.25, 0.50 and 1.00 mg kg⁻¹. The recovery of acephate and methamidophos from fortified

cucumber fruits varied from 97.00-98.80 and 92.00-98.00 per cent and cropped soil 97.00-104.00 and 89.00-103.40 per cent. These results of present findings showed a close similarity to those obtained by Cabras *et al.*, (2000) where the recovery of acephate obtained from olives ranged between 83.00-110.00 per cent with fortification levels ranged between 0.01-2.00 mg kg⁻¹. On the other hand, Mohapatra *et al.*, (2011) revealed that recovery of acephate from mango orchard soil was in the range of 89.75–91.44 per cent.

Recovery of chlorpyrifos from fortified cucumber fruits and soil varied from 95.40-101.00 and 92.80-100.90 per cent at fortification level ranging between 0.05-1.00 mg kg⁻¹ (Table 1). Similar trend of recoveries has been reported by Samriti *et al.*, (2012) who recovered 94.00-96.75 per cent and 89.00-92.00 per cent chlorpyrifos from okra fruit at fortification levels of 0.10 and 0.25 mg kg⁻¹, respectively. The results showed a closed similarity with the findings of Jyot *et al.*, (2013) who reported soil recovery ranging from 86.07-88.05 per cent for chlorpyrifos in green chillies.

Persistence studies in cucumber fruits

Acephate and its metabolite (methamidophos)

The average initial deposits of acephate on cucumber were found to be 0.640 mg kg⁻¹ and 1.123 mg kg⁻¹ at 560 g a.i. ha⁻¹ and 1120 g a.i. ha⁻¹. In cucumber fruits acephate was converted into a toxic compound, methamidophos whose residues were also determined. The initial deposit of acephate was dissipated to 0.091 mg kg⁻¹ and 0.097 mg kg⁻¹ after 5 and 7 days at single and double dosages, respectively (Table 2). Acephate deposits on cucumber fruit at recommended dose were 1.7 times lower than that obtained from double the recommended dose. The

results showed a close similarity to those obtained by Mohapatra *et al.*, (2011) who reported 1.6 folds increase in deposits due to higher dose over crop on lower dose. The residues of methamidophos were not-detected after 2 hours of the acephate application. However, methamidophos residues detected after 1 day were 0.057 mg kg⁻¹ in single dose and 0.091 mg kg⁻¹ in double. After 5 days residues of methamidophos were not detected.

Chlorpyrifos

The average initial deposits of chlorpyrifos were 0.980 mg kg⁻¹ at single dose (300 g a.i. ha⁻¹) and 1.860 mg kg⁻¹ at double dose (600 g a.i. ha⁻¹) on cucumber fruits. The initial deposits dissipated to 0.059 mg kg⁻¹ after 7 days of spraying at recommended dose (300 g a.i. ha⁻¹) and at double the recommended dose dissipated to 0.057 mg kg⁻¹ in 10 days, respectively (Table 3). The dissipation of the initial deposit were found to be 93.98 per cent (recommended dose) and 96.93 per cent (double the recommended dose) at 7 and 10 days interval, respectively. Our results are in agreement with Samriti *et al.*, (2012) who studied that the chlorpyrifos dissipated 92.00 per cent after 10 days in okra when applied at single (275 g a.i. ha⁻¹) and double dose (550 g a.i. ha⁻¹).

Dissipation kinetics

Present studies revealed that the dissipation kinetics of acephate and chlorpyrifos follows first order kinetics.

The waiting period of acephate on cucumber fruits was found to be 6.59 and 8.57 days at single and double doses, respectively (Table.4). These values are closer to those obtained by Reddy and Rao (2005), who found 5.13 days waiting period for harvesting of acephate treated grape berries at 0.75 kg a.i. ha⁻¹.

Fig 1 Chromatographic response of different concentrations of acephate and its metabolite methamidophos in cucumber

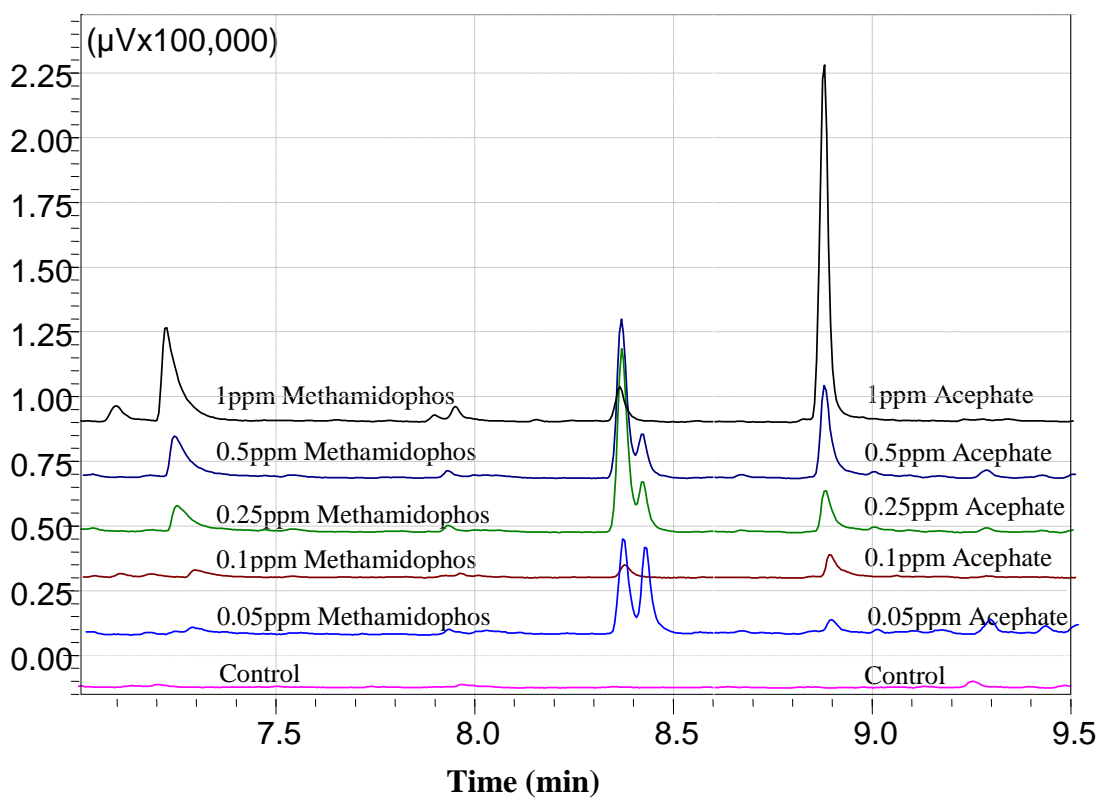


Fig 2 Linearity of acephate and its metabolite methamidophos in cucumber

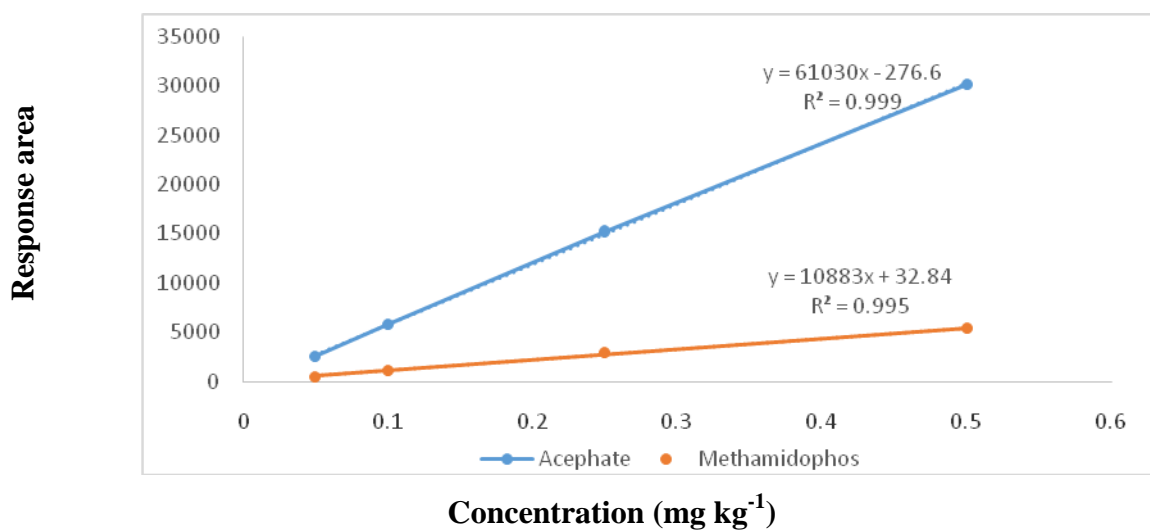


Fig 3 Chromatographic response of different concentrations of chlorpyriphos in cucumber

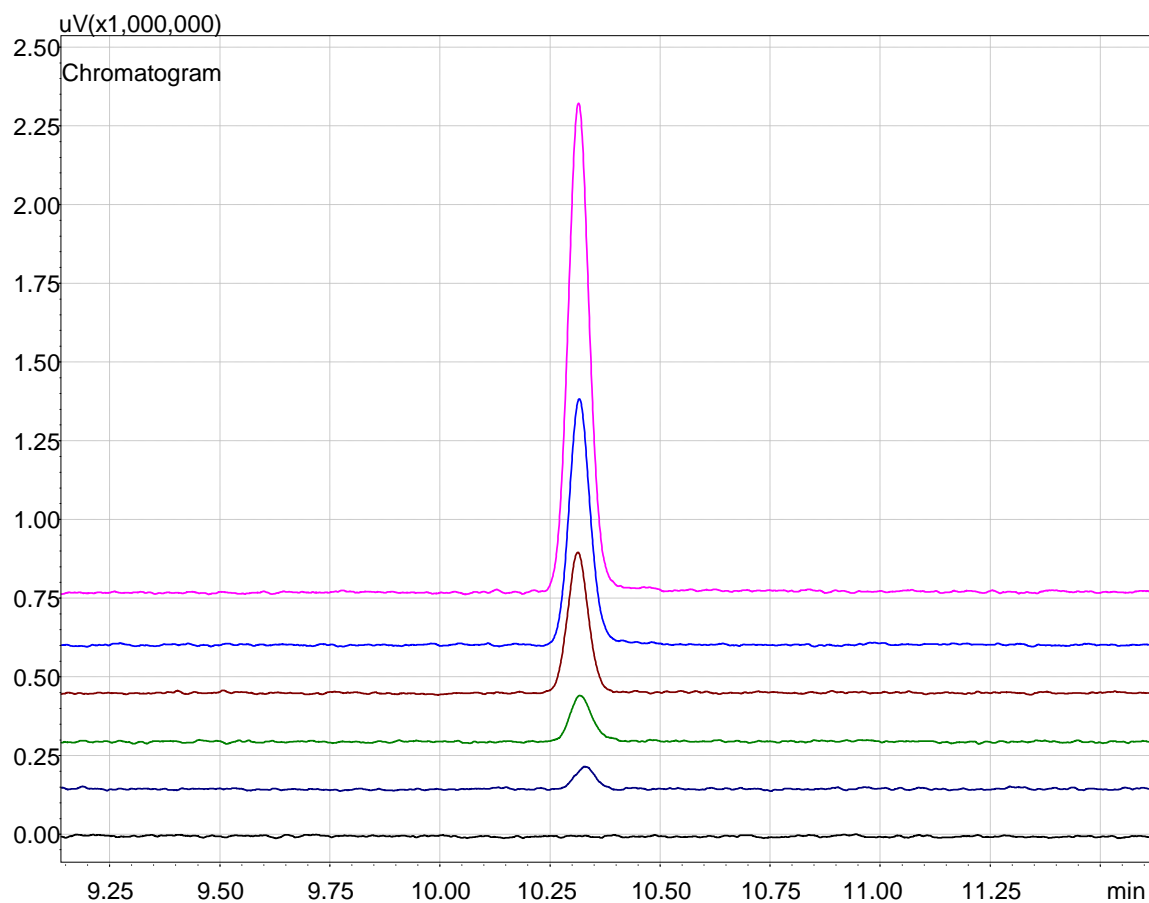


Fig 4 Linearity of chlorpyriphos in cucumber

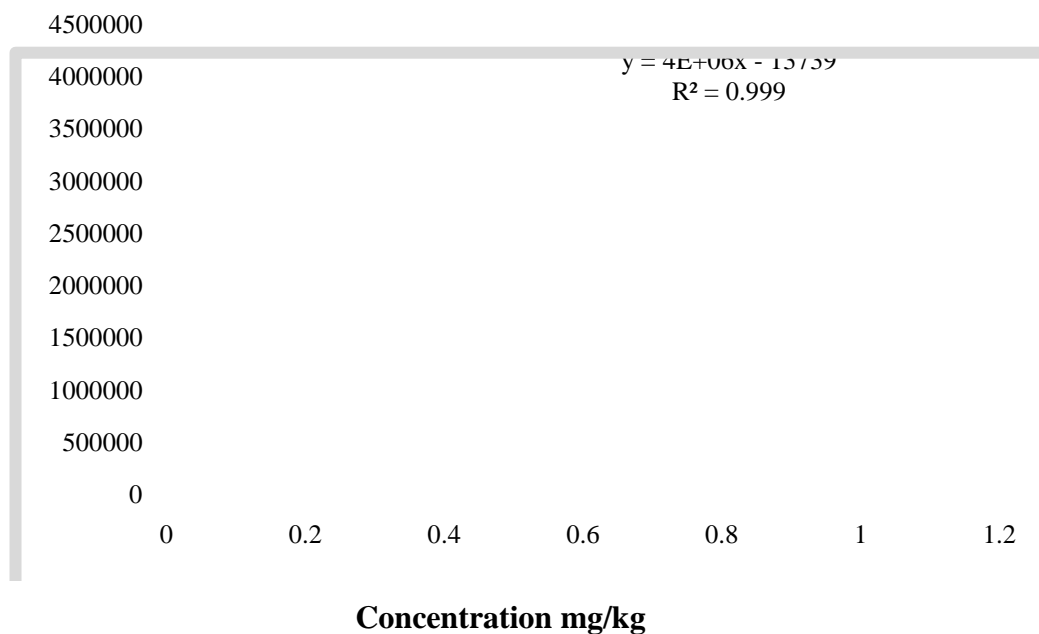


Fig.5 Dissipation pattern of Σ acephate when applied @ 560 g a.i. ha⁻¹ and 1120 g a.i. ha⁻¹

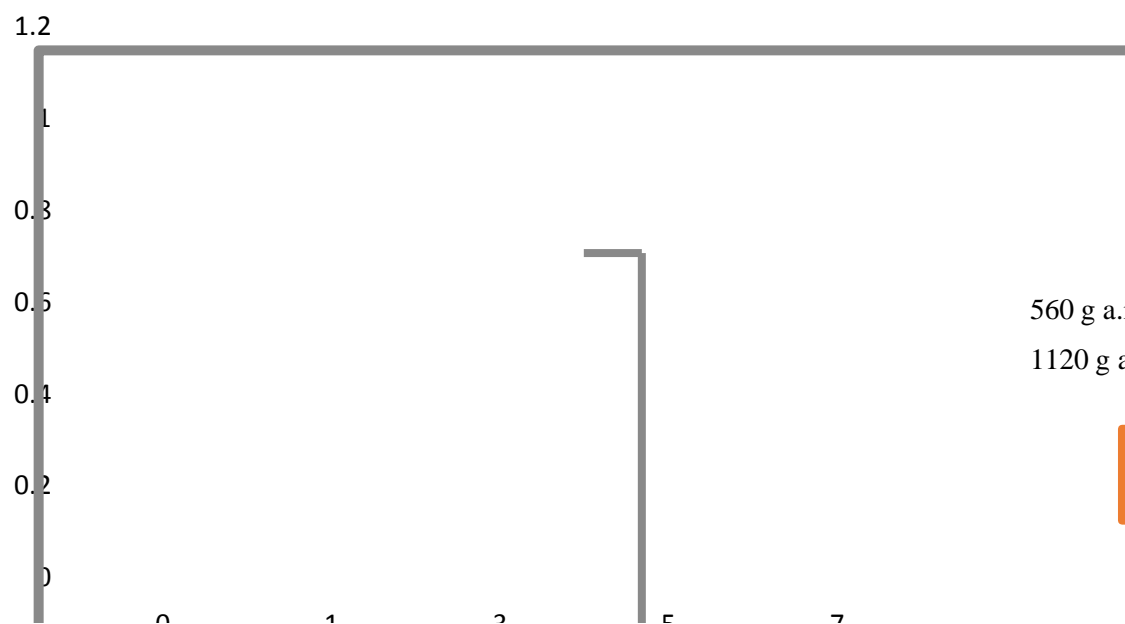


Fig 6 Dissipation pattern of chlorpyriphos when applied @ 300 g a.i. ha⁻¹ and 600 g a.i. ha⁻¹

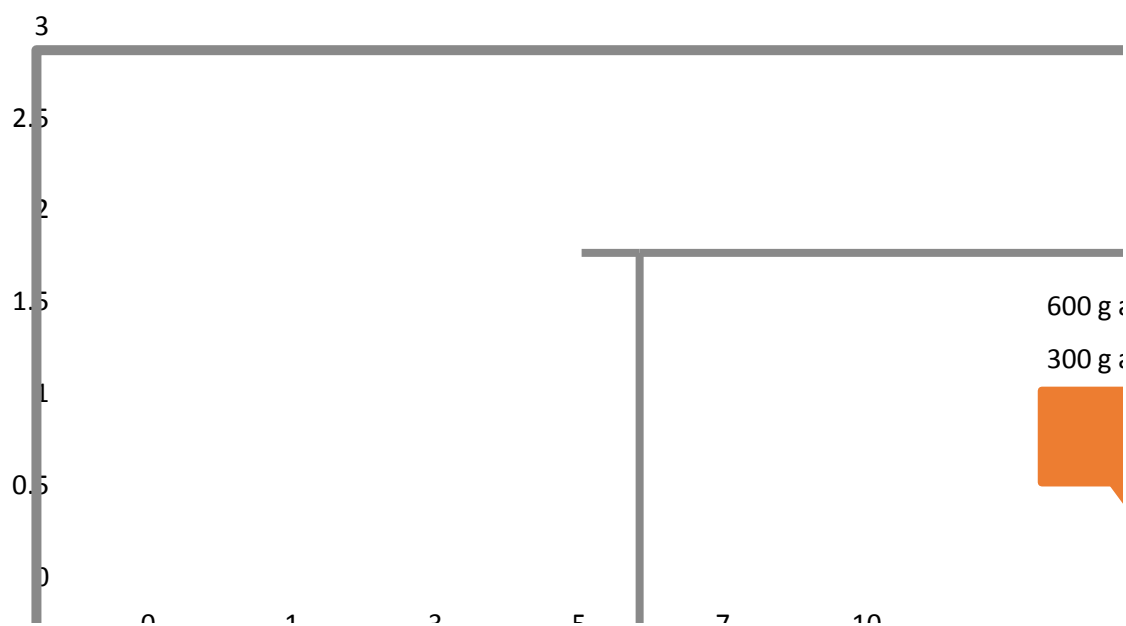


Fig.7 Effect of culinary processes on acephate residues in cucumber fruits

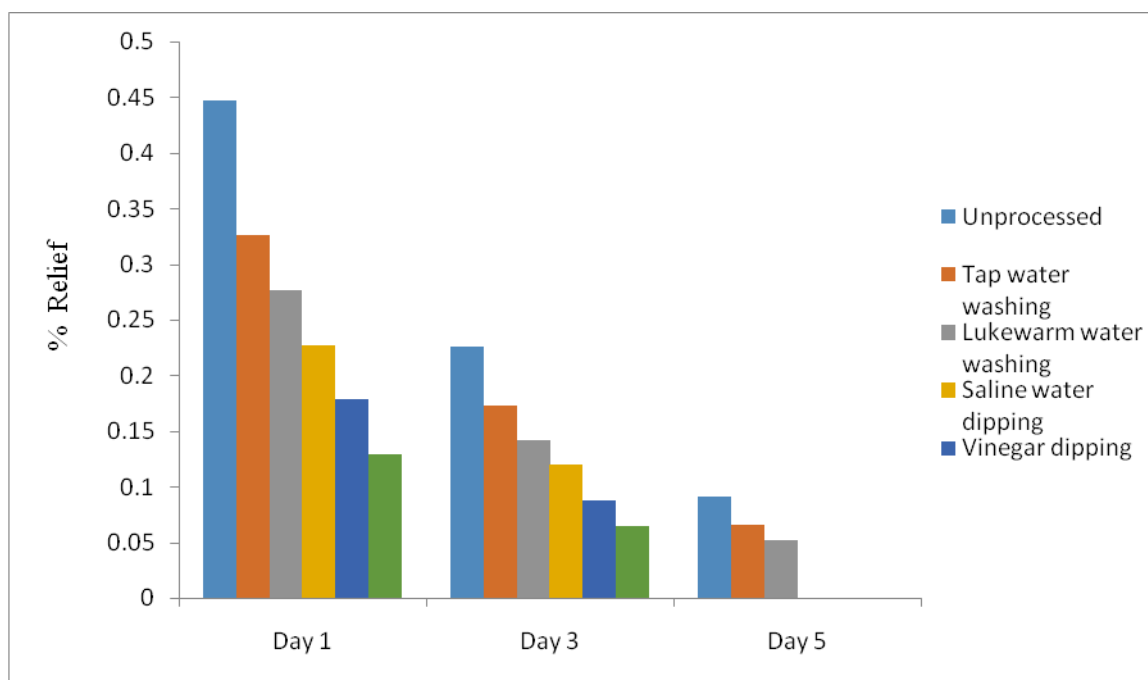


Fig.8 Effect of culinary processes on chlorpyrifos residues on cucumber fruits

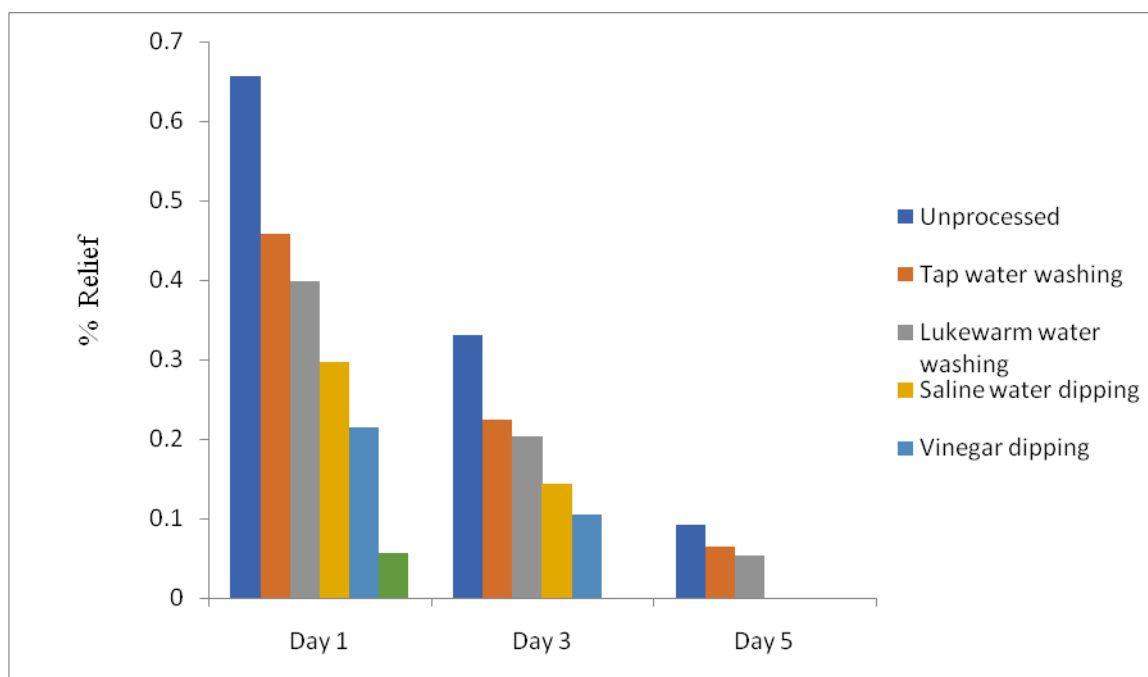


Table.1 Per cent average* recovery of acephate, methamidophos and chlorpyrifos from fortified cucumber fruits and soil

Fortification level (mg kg ⁻¹)	Acephate		Methamidophos		Chlorpyrifos	
	Fruit mean recovery (%)	Soil mean recovery (%)	Fruit mean recovery (%)	Soil mean recovery (%)	Fruit mean recovery (%)	Soil mean recovery (%)
0.05	98.00 (0.006)	104.00 (0.008)	98.00 (0.005)	100.00 (0.007)	98.00(0.005)	97.40 (0.005)
0.1	97.00 (0.012)	97.00 (0.012)	92.00 (0.013)	89.00 (0.009)	101.00 (0.008)	96.00 (0.009)
0.25	98.80 (0.018)	101.60 (0.023)	96.00 (0.027)	102.00 (0.009)	99.20 (0.029)	94.00 (0.030)
0.5	98.20 (0.047)	100.20 (0.043)	94.20 (0.034)	103.40 (0.017)	95.40 (0.019)	92.80 (0.053)
1	98.60 (0.077)	99.60 (0.080)	96.60 (0.063)	97.40 (0.053)	98.70 (0.019)	99.20 (0.012)

*Average of 5 replications; Value in parentheses are % RSD of 5 replicates

Table 2 Persistence of acephate and methamidophos residues at the application rate of 560 and 1120 g a.i. ha⁻¹ in cucumber

(n= 3)

Insecticides	Interval	Dose 560 g a.i. ha ⁻¹		Dose 1120 g a.i. ha ⁻¹	
		Mean residues ± SD (mg kg ⁻¹)	Dissipation %	Mean residues ± SD (mg kg ⁻¹)	Dissipation %
Acephate	0	0.640 ± 0.047	-	1.123 ± 0.008	-
Methamidophos		-	-	-	-
ΣAcephate		0.640 ± 0.047	-	1.123 ± 0.008	-
Acephate	1	0.447 ± 0.030	-	0.998 ± 0.007	-
Methamidophos		0.057 ± 0.003	-	0.091 ± 0.005	-
ΣAcephate		0.504 ± 0.029	21.25	1.090 ± 0.012	2.94
Acephate	3	0.226 ± 0.027	-	0.504 ± 0.007	-
Methamidophos		0.087 ± 0.005	-	0.114 ± 0.002	-
ΣAcephate		0.313 ± 0.030	51.09	0.618 ± 0.009	44.62
Acephate	5	0.091 ± 0.012	-	0.206 ± 0.009	-
Methamidophos		0.057 ± 0.005	-	0.060 ± 0.003	-
ΣAcephate		0.147 ± 0.010	77.03	0.266 ± 0.011	75.55
Acephate	7	BDL	-	0.097 ± 0.006	-
Methamidophos		-	-	-	-
ΣAcephate		-	-	0.097 ± 0.006	91.03
Acephate	10	-	-	BDL	-
Methamidophos		-	-	-	-

ΣAcephate		-	-	-	-
Acephate	Control	ND	-	ND	-
Methamidophos		-	-	-	-
ΣAcephate		-	-	-	-

n= number of replications

Table 3 Persistence of chlorpyrifos residues at the application rate of 300 g a.i. ha⁻¹ and 600 g a.i. ha⁻¹ in cucumber

(n= 3)

Interval	Dose 300 g a.i. ha ⁻¹		Dose 600 g a.i. ha ⁻¹	
	Mean ± SD (mg kg ⁻¹)	Dissipation (%)	Mean ± SD (mg kg ⁻¹)	Dissipation (%)
0	0.980 ± 0.010	-	1.860 ± 0.078	-
1	0.656 ± 0.007	33.06	1.126 ± 0.006	39.46
3	0.330 ± 0.008	66.32	0.623 ± 0.026	66.50
5	0.092 ± 0.003	90.61	0.201 ± 0.10	89.20
7	0.059 ± 0.003	93.98	0.102 ± 0.004	94.52
10	BDL	-	0.057 ± 0.005	96.93
15	-	-	BDL	-
Control	-		-	-

n= number of replication

Table 4 Statistical constants of test insecticides in cucumber fruits

Statistical Constants	Acephate		Chlorpyrifos	
	560 g a.i. ha ⁻¹	1120 g a.i. ha ⁻¹	300 g a.i. ha ⁻¹	600 g a.i. ha ⁻¹
Regression equation	Y= -0.180-0.168X	Y= 0.116-0.158X	Y = -0.001 - 0.183X	Y= 0.212-0.1157 X
Half life (RL₅₀) (d)	1.79	8.57	1.64	1.91
Waiting period (d)	6.59	1.91	7.05	9.98
Correlation coefficient (R²)	-0.997	-0.994	-0.990	-0.987

d- days

Table 5 Persistence of acephate, methamidophos and chlorpyrifos residues in cucumber cropped soil

(n=3)

Interval	Acephate (Mean residues \pm SD) mg kg ⁻¹		Chlorpyrifos (Mean residues \pm SD) mg kg ⁻¹	
	560 g a.i. ha ⁻¹	1120 g a.i. ha ⁻¹	300 g a.i. ha ⁻¹	600 g a.i. ha ⁻¹
0	0.76 \pm 0.005	0.161 \pm 0.006	0.112 \pm 0.002	0.198 \pm 0.003
3	BDL	BDL	BDL	0.056 \pm 0.005 (71.72)
7	-	-	-	BDL
			-	-

n= number of replication; Values in parentheses are % dissipation

The half life of acephate has been reported as 1.9-2.0 days in cotton (Battu *et al.*, 2007) and 1.4 days in pakchoi (Chuanjiang *et al.*, 2010), confirming the similarity of results obtained in the present study.

Chlorpyrifos waiting period on cucumber fruits was 7.05 days at recommended dose (300 g a.i. ha⁻¹) and 9.98 days at double the recommended dose (600 g a.i. ha⁻¹). These values are closed to those obtained by Raina and Raina (2008) who concluded safe waiting period of 5.0-6.3 and 7.1-7.3 days for chlorpyrifos on cauliflower at the application rate of 500 g a.i. ha⁻¹ and 1000 g a.i. ha⁻¹, respectively for two years. In chlorpyrifos, deposits dissipated to half at recommended dose in 1.64 days as compared to 1.91 days at double the recommended dose from cucumber fruits indicating dissipation behavior of insecticide at both doses. Raina and Raina (2008) reported the half life of chlorpyrifos on cauliflower as 1.40-1.50 and 1.50-1.60 days for lower and higher dose, respectively, for two consecutive years which shows similarity with the present findings.

Persistence study in cucumber cropped soil

Acephate and its metabolite (methamidophos)

The residue analysis showed that the average

initial deposits of acephate (0.076 mg kg⁻¹) in cucumber cropped soil were found to be below the level of determination (BDL) on 3rd day of acephate application at the rate of 560 g a.i. ha⁻¹. On the contrary, when acephate was applied @ 1120 g a.i. ha⁻¹ on cucumber, the initial deposit in soil was 0.161 mg kg⁻¹ which was found also to be below BDL on 3rd day of application. The results of the present investigation showed deviation from those recorded by Chai *et al.*, (2009) who observed that acephate dissipated completely from soil at 7-14 days after last spraying from mustard. The dissimilarity in the dissipation pattern of acephate in soil may be due to difference in doses applied and variations in climatic conditions of the locations.

Chlorpyrifos

The average initial deposits of 0.112 mg kg⁻¹ in soil was found to be below the level of determination on 3rd day of treatment of chlorpyrifos at the rate of 300 g a.i. ha⁻¹. On the contrary, application of chlorpyrifos @ 600 g a.i. ha⁻¹, the initial deposits of 0.198 mg kg⁻¹ in cropped soil further degraded to 0.056 mg kg⁻¹ on day 3 of application and were not further detected on 7th day after spraying. Samriti *et al.*, (2012) recorded initial deposits of 0.015 and 0.036 mg kg⁻¹ in soil at the application of chlorpyrifos (275 and 550 g a.i. ha⁻¹) on chilli crop.

Effect of Processing on Insecticide Residues

Washing of vegetables with running tap water is the commonly used practice in the homes before the preparation and final consumption by the consumers. Data in the Figure 7 revealed that when the treated cucumber fruits collected at 1, 3 and 5 days were washed with running tap water for 2 minutes, the acephate residues reduced to 0.326, 0.173 and 0.066 mg kg⁻¹, respectively and the per cent relief obtained to the tune of 27.07, 23.49 and 27.47, respectively. In other practice, dipping of acephate treated cucumber fruits in lukewarm water (35-40⁰ C) for 5 minutes revealed that the residues reduced to 0.276, 0.142 and 0.052 mg kg⁻¹. Brar (2013) reported 37.19-54.54 per cent relief of acephate residues from brinjal fruits after dipping in lukewarm water. Acephate treated cucumber fruits when washed in 2 per cent salt solution for 5 minutes, reduced the residues to an extent of 0.227 and 0.120 mg kg⁻¹ on 1st and 3rd day and showed 49.14 and 46.97 per cent relief, whereas, 100.00 per cent relief was obtained in 5th day samples of cucumber. Our results are in close conformity with Singh (2013) who reported 34.88-42.41 per cent relief from acephate residues in capsicum when processed with 2 per cent saline water. 1st day and 3rd day samples of cucumber when dipped in 5 per cent acetic acid for 5 minutes, residues of acephate reduces to 0.178 and 0.088 mg kg⁻¹ that showed 60.18 and 60.86 per cent relief. Similarly, Reddy and Rao (2005) reported that dipping of grapes in 1 per cent acetic acid solution for 10 minutes followed by washing facilitated 40.00-95.00 per cent removal of acephate. The majority of insecticides or fungicides applied directly to crops undergo very limited movement or penetration into the cuticle. Therefore, residues of these materials are confined to the outer surfaces where they are amenable to removal in peeling, hulling or trimming operations (Holland *et al.*, 1994). Similar observations have been recorded in the

present investigations as where peeling of 1st and 3rd day cucumber fruits reduces the acephate residues to 0.129 and 0.064 mg kg⁻¹. The per cent relief obtained to the tune of 71.07 and 71.79, respectively.

The chlorpyrifos (300 g a.i. ha⁻¹) treated cucumber fruit sampled at 1, 3 and 5 days were washed with tap water, the residues reduced to 0.458, 0.225 and 0.064 mg kg⁻¹, respectively and the per cent relief obtained to the tune of 30.23, 31.79 and 30.07, respectively. These results are in conformity with Samriti *et al.*, (2011) who reported that tap water washing of okra reduced residues of chlorpyrifos in the range of 18.75–31.34 per cent Randhawa *et al.*, (2007) reported that chlorpyrifos residues reduced by 33.00 per cent in spinach, 30.00 per cent in potato, 25.00 per cent in cauliflower and 10.00 per cent in tomato by washing with tap water. When chlorpyrifos treated cucumber fruits dipped in lukewarm water, residues reduced in the range 0.399 to 0.054 mg kg⁻¹ showed 39.18 to 40.94 per cent relief same as Banshtu (2012) who reported a relief of 16.00-41.21 per cent when chlorpyrifos treated cauliflower curds were decontaminated with lukewarm water. In our study, dipping of chlorpyrifos treated cucumber fruits with saline water at 1st and 3rd day reduced the residues to the extent of 54.73 and 56.81 per cent, respectively.

The results obtained by Chandra *et al.*, (2015) are similar to our findings according to which treatment with 2 per cent NaCl in water reduces the chlorpyrifos residues to 62.50-65.60 per cent in brinjal.

Vinegar dipping degraded the chlorpyrifos residues of 1st and 3rd day to 0.215 and 0.105 mg kg⁻¹ which contributed to 67.28 and 68.21 per cent relief, respectively.

Two per cent vinegar reduces the residues of chlorpyrifos to 50.67 per cent from okra

fruits collected at 1st day after spray (Nair *et al.*, 2014). In chlorpyrifos treated fruits, the residues reduced to 0.057 mg kg⁻¹ in 1 day sampled cucumber fruits and the per cent relief obtained to the tune of 91.36 whereas 100.00 per cent relief was obtained in 3rd day sampled fruits. Peeling also had a significant effect on the removal of chlorpyrifos and its degradation products from potatoes and eggplant (Randhawa *et al.*, 2007).

From the present investigation it was concluded that residues of acephate and chlorpyrifos on cucumber fruits persist for 5 and 7 days at recommended dose, whereas, acephate and chlorpyrifos residues persisted for 7 and 10 days at double the recommended dose, respectively.

The waiting period of 7-10 days is suggested for both the pesticides. Residues of acephate persisted only for 0 day at recommended and double the recommended dose. On the hand chlorpyrifos residues persisted for 0 and 3 days at recommended dose and double the recommended dose, respectively. Among the common household practices peeling was found most effective in reducing the residues.

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