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Studies on insecticide usage pattern and pesticide residues in commercially grown curry leaf crop

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Abstract: Curry leaf (*Murraya koeinigii*) is commercially grown in Kayathar and Ottapidaram blocks of Tuticorin district in the southern part of Tamil Nadu, India. In the present study, the insecticide use pattern was investigated through a standard questionnaire and the residue on foliage was analyzed using QuEChERS method. Major pests reported by the farmers in this region were psyllids (*Diaphorina citri*) (93.33%) and whiteflies (*Aleurodicus disperses*) (84.44%) during the pre-monsoon season. It was revealed that curry leaf farmers relied mainly on insecticides for management of insect pests guided by local pesticide dealers and used as a cocktail mixture. Only 26.67 per cent of the farmers were aware of IPM options. Around 15 insecticides including four combination products were used in this region.The results of the residue analysis conducted on 30 farm-gate samples, show the presence of insecticide residues in 83.33 per cent of the samples.Though there is no MRL value available for curry leaf, the maximum level of residues was recorded in respect of profenophos (0.578 mg kg^{-1}), Fenpropathrin (0.241 mg kg^{-1}) and afidopyropen (0.197 mg kg^{-1}). The results of the present study demand for the need of IPM awareness programme including educating the farmers and pesticide dealers on sensible use of recommended pesticides in curry leaf farming. So that curry leaf produced in this region can be are of pesticide-free.

Keywords: Curry leaf, pesticide usage pattern, pesticide residue, Tamil Nadu

INTRODUCTION

Curry leaf (*Murrayakoeinigii* (L.) Sprengel), (Family: Rutaceae) is an important export oriented commercial spice (Khan *et al.*, 1997) which is rich in vitamin A, vitamin B and calcium content. Fresh leaves, dried leaf powder and essential oil are broadly used for flavoring dishes and many ready to use food preparations as food enhancers (Joseph *et al.*, 1985). Curry leaf is cultivated in southern states like Tamil Nadu, Kerala and Andhra Pradesh (Swarupa *et al.*, 2017). There were many insect pests reported on curry leaf crop in commercially cultivated areas that cause crop quality and quantity loss and which attracts repeated insecticide application.12 insect species were reported infesting curry leaf plants (Tara *et al.*, 2010). Of them citrus leaf roller (*Psorosticha zizyphi)* and psyllids (*Diaphorina citri)*are two major pests causing extensive damage in many locations (Devaki *et al.*, 2012). The other sporadic pest reported includes the citrus butterflies (*Papilio polytes)*, scales (*Coccoidea spp)*, whiteflies (*Aleurodicus disperses*) and mealybugs (*Planococcus citri*). In recent past, due to pesticide contamination, the curryleaf exported from India attracted red alert from European Union, the primary importer of curry leaves (Mohan, 2012 ; Swarupa et al., 2017). There is no published report available on the insecticide use behavior of curryleaf cultivating farmers and the level of insecticide residue in the harvested leaves in southern districts in TamilNadu. Keeping the above knowledge gap, the study was undertaken to survey the pesticide use pattern of farmers and also to assess the level of pesticide contamination in the fresh leaves in Tuticorin district were curry leaf cultivated as a commercial perennial crop.

MATERIALS AND METHODS

Survey

The pesticide usage pattern and the behaviour of curry leaf farmers were studied through a field survey during 2020 in Kayathar and Ottapidaram blocks in Tuticorin district, Tamil Nadu, India.In this area, curry leaf is grown on an area of 84 ha as a perennial ratoon crop for the domestic and export market. The survey was conducted through personal visits through a structured questionnaire.A total of 45 farmers were interviewed. Some of the key parameters related to plant protection like IPM awareness, socio-economic aspects, pest problems and their seasonality, type of pesticide used, dose, time of application and type of plant protection appliance used are collected.The collected information was scientifically scrutinized and subjected to statistical

Table 1. The details of the survey locations in Tamil nadu

Location	Name of the Village	Number of farmers surveyed
Kayathar Block,	Akilandapuram	9
Tuticorin District	Karisalkulam	10
	Thalaivaipuram	7
Ottapidaram Block	Parivillaikottai	6
Tuticorin District	Thennampatti	13

analysis. The details of the survey location are given in the following table.

Pesticide Residue Analysis

A total of 30 farm-gate samples of curry leaf were collected from the experimental area and analyzed for pesticide residue content in the Toxicology laboratory, Department of Agricultural Entomology, Killikulam.The universally accepted QuEChERS method (Anastassiades *et al.*, 2003) of pesticide residue analysis was followed.

Curry leaf samples were analyzed for pesticide residues following the AOAC official method (QuEChERS), which is the best method in the laboratory. The samples were collected in polythene bags from the curry leaf-growing areas of Thoothukudi district. Curry leaves were homogenized separately with the robot coupe Blixer. 10g of sample was weighed and taken in 50 ml centrifuge tube and 30 ml acetonitrile was added. The sample was homogenized at 14000-15000 rpm for 2-3 min. 6g of sodium chloride was added to the sample, mixed thoroughly by shaking gently, followed by centrifugation for 3min at 2500-3000rpm to separate the organic layer. The top organic layer of about 9 ml was taken into the 15ml centrifuge tube and added with 1.4g of magnesium sulphate to remove the moisture content, 0.5g of PSA sorbent (for dispersive solid phased-SPE cleanup) and 0.05g of GCB (Graphitized Carbon Black), shaken gently followed by centrifugation for 2 min at 2500rpm.The sample tube was vortexed for 30 sec, followed by a centrifuge for 5 min at 2500-3000rpm. A 2ml supernatant layer was transferred into a 10ml tube for evaporation using turbo-vap and taken for LC-MS analysis.

The analytical method adopted for estimating pesticide residues from the matrix (curry leaves) was validated through a recovery experiment. The recovery experiment was conducted by 10g of curry leaf from pesticide-free control plot and the matrix was taken in 50 ml centrifuge tubes then spiked with a particular pesticide at three fortification levels *viz.* 0.05 mg kg^{-1} (LOQ), 0.25 mg kg^{-1} (5 x LOQ) and 0.5mg kg^{-1} (10 x LOQ). The method's repeatability was determined in terms of relative standard deviation (RSD, in percent) from recovery studies for three replicates of each pesticide at each fortification level. The tubes containing fortified samples were left open for a while to allow the excess solvent to evaporate. The samples were processed using the same extraction procedure. The evaporated sample reconstitute with 1ml of methanol was in vials for LC-MS/MS analysis under the recommended operational conditions.

RESULTS AND DISCUSSION

Insecticide usage pattern

In the survey areas of Kayathar and Ottapidaram block in Thoothukudi district,curry leaf is grown in 84 ha. Besides a local variety, two improved varieties viz., Senkambu and Dharward are cultivated in this region and the introduced varieties are more susceptible to pest damage. Senkambu is a common variety grown by 62.22 per cent of the farmers, followed by the cultivar Dharward (31.11%). Observation on pest incidence indicated that citrus psyllids *(Diaphorina citri)* and whitefly *(Aleurodicus disperses*) during the pre-monsoon season, leaf miner *(Psorosticha zizyphi)* during the monsoon season and two-spotted mites (*Tetranychus* spp.*)* during the dry season were the most common. Among the 45 farmers studied, psyllids were indicated as a major problem by 93.33 per cent of the farmers followed by whiteflies (84.44%). The other pests, leaf miner (71.11%) and two-spotted mites (48.89%) were also reported by the farmers. The use of intensive cultivation practices like fertigation, pruning, irrigation and misuse of insecticide are the reasons observed for higher pest incidence. According to Swarupa *et al.* (2017) more infestation of pests and an increase in resistance of insect pests to different pesticides have some farmers shifting their cultivation to other crops. For managing insect pest there were 11 insecticides used in this region, either alone or as a cocktail tank mix. Among the 11 insecticides four are of binary mixtures, which include Profenophos 40 %+ Cypermethrin 4% EC, Betacyfluthrin 8.49 + Imidachoprid 19.81 OD, Profenophos 40+ Fenpyroximate 2.5 EC, Acephate 50 + Imidacloprid 1.8 SP. A combination product Profenophos 40 %+ Cypermethrin 4% is being used by 62.2 per cent of the farmers interviewed. They resort to using the particular product based on its field performance. The

Table 2. Pesticide usage pattern on curry leaf crop against different insect pests

Insecticides	Type of formulation	Trade name	Frequency (no.)	Percentage (%)
Imidacloprid	17.8 SL	Confidor	4	8.89
Betacyfluthrin + Imidacloprid	8.49 + 19.81 OD	Solomon	12	26.67
Profenophos + Cypermethrin	40 + 4 EC	Hitcel	28	62.22
Acephate + Imidacloprid	50 + 1.8 SP	Lancer	9	20.00
Acetamiprid	20 SP	Ekka	2	4.44
Thiamethoxam	25 WG	Eco-champ	16	35.56
Profenophos + Fenpyroximate	40 + 2.5 EC	Excel	10	22.22
Lambdacyhalothrin	2.5EC	Karate	18	40.00
Fenpropathrin	30 EC	Danitol	24	53.33
Afidopyropen	50 DC	Sefina	15	33.33
Monocrotophos	36 SL	Phoskill	7	15.56
Fungicides				
Carbendazim + Mancozeb	12 WP + 63 WP	Saaf	34	75.56
Tebuconazole + Trifloxystrobin	50 + 25 WG	Nativo	19	42.22
Metiram + Pyraclostrobin	55 + 5WG	Cabrio top	12	26.67

other pesticides were in the order of Fenpropathrin 30 EC (53.33%) >Lambda cyhalothrin 2.5 EC (40%) > Thiamethoxam 25 WG (35.56%) >Afidopyropen 50 DC (33.33%) >Betacyfluthrin 8.49 + Imidacloprid 19.81 OD (26.67%) >Profenophos 40+ Fenpyroximate 2.5 EC (22.22%) >Acephate 50 + Imidachloprid 1.8 SP (20%) >Monocrotophos 36 SL (15.56%) > Acetamiprid 20 SP (4.44%) (Table 2). Information gathered on general awareness of farmers on the usage of pesticides in curry leaf crop revealed that majority of them (73.33%) not having any knowledge/awareness on pesticide dose recommendation and 26.67 per cent of the farmers have awareness about the use of correct amount of pesticides because of the training they undergone with department/ Agricultural University and about 60 per cent of the farmers use insecticides more than two times in a month and the remaining use pesticides at least two times in a month.It is also noticed 80 per cent of the farmershave the habit of mixing fungicides with insecticides as tank mixes to save time, labor and money.With respect to plant protection appliances, 88.89 per cent of them uses power operated high volume sprayer and for technical information majority of them (68.89%) refers shop dealers and only 24.44 per cent visits extension officials for IPM knowledge. This is due to a lack of interest.A similar survey conducted in curry leaf by (Swarupa *et al.*, 2017) in Andhra Pradesh reported the majority of the farmers contact shop dealers for pesticide recommendations. None of them have awareness on protective clothing and most of them (84.44%) wear full-hand shirts while doing spray operation (Table 3).

Monitoring of pesticide residue in curry leaves

The method validated for the estimation of different insecticides in curry leaves gave good recovery of the target residues from the substrates. The recovery percentage of 15 pesticides tested ranged from 75.21 to 109.3. The Relative Standard Deviation in respect of methods repeatability of 15 pesticides ranges from 0.61 percent to 9.24 percent (Table 4).The present observation on recovery and methods repeatability for the residue analysisprocedure is similar with such studies conducted by(Rani *et al.*, 2016).Of the 30 farm-gate samples of curry leaf analyzed, 83.33 per cent (25 samples) were detected with pesticide residue. Five samples were detected with profenophos residue ranging from 0.040 to 0.578 mg/kg). Cypermethrin (0.011-0.092 mg/kg) and fenpropathrin (0.037-0.241 mg/kg) were each detected in four samples. The new molecule afidopyropen, a widely used pesticide in this region was also detected in three samples (0.032-0.197 mg/kg). The conventional compound acephate (0.09–0.012 mg/kg) and imidachloprid(0.065-0.114 mg/kg) were detected in two samples.Other pesticide detected includesacetamiprid(0.071 mg/kg), beta-cyfluthrin(0.083mg/kg), chlorpyriphos(0.076 mg/kg), dimethoate(0.032mg/kg), emamectin benzoate (0.027 mg/kg), lambda-cyhalothrin(0.080 mg/kg),

Table 3. General awareness of farmers on usage of pesticides on curry leaf crop

Particulars	Frequency (no.)	Percentage (%)
Awareness on recommendations of pesticides		
With Awarness	12	26.67
Without Awarness	33	73.33
Farmers desire to mix different pesticides		
Insecticide + Insecticide	18	40.00
Insecticide + Fungicide	36	80.00
Fungicide + Fungicide	14	31.11
Source of Technical information		
Agricultural officer	11	24.44
Dealer	31	68.89
Scientists	3	6.67
Frequency of application		
Twice per month	18	40.00
More than twice per month	27	60.00
Disposal method followed for empty pesticide bottles		
Used for house or farm purpose	5	11.11
Sell	4	8.89
Throw into trash	36	80.00
Selection of spraying equipment		
Knapsack sprayer	5	11.11
Power sprayer	40	88.89
Precautions while application of pesticides		
Face mask	4	8.89
Shirts with full hands	38	84.44
No precaution	2	4.44

Table 4. Recovery of insecticides on curry leaves at different fortification levels

Insecticide	Level of fortification					
	0.05 mgkg^{-1}(LOQ)		0.25 mg kg^{-1}(5 x LOQ)		0.50 mg kg^{-1}(10 x LOQ)	
	Mean recovery (%) ± SD	RSD	Mean recovery (%) ± SD	RSD	Mean recovery (%) ± SD	RSD
Acephate	99.71± 1.71	1.72	97.38± 0.72	0.74	101.47± 2.74	2.70
Acetamiprid	101.33±2.15	2.12	95.55±2.57	2.69	94.72±2.54	2.69
Afidopyropen	84.92±1.77	2.09	82.70±1.67	2.02	91.03±2.41	2.65
Betac yfluthrin	81.32±1.15	1.41	93.53±2.71	2.89	103.47±1.55	1.50
Cypermethrin	98.60±2.65	2.68	86.11±1.48	1.72	85.66±7.92	9.24
Chlorpyriphos	82.49±2.31	2.81	94.41±0.58	0.61	86.38±1.08	1.25
Dimethoate	86.92±2.89	3.33	99.91±1.37	1.38	109.30±0.84	0.77
Emamectin benzoate	76.50±2.58	3.37	89.39±1.03	1.15	101.92±1.23	1.21
Ethion	99.72±2.34	2.35	102.12±3.40	3.32	97.08±2.55	2.62
Fenpropathrin	75.21±2.82	3.75	95.31±1.12	1.18	95.78±2.46	2.57
Imidacloprid	94.64±2.93	3.09	89.38±2.64	2.95	89.06±2.89	3.25
Lambda cyhalothrin	105.31±3.95	3.75	103.62±1.62	1.56	98.81±3.35	3.39
Monocrotophos	84.34±1.67	1.98	81.57±1.00	1.22	86.88±1.63	1.88
Profenophos	96.36±2.42	2.52	103.23±2.49	2.42	93.26±1.50	1.61
Phosalone	81.95±1.35	1.65	87.31±1.37	1.57	102.23±1.53	1.50

SD = Standard Deviation, RSD = Relative Standard Deviation, LOQ=Limit of Quantification (LOQ)

Table 5. Residues of different insecticides on curry leaves

Samples	Acephate	Acetamiprid	Afidopyropen	Betacyfluthrin	Cypermethrin	Chlorpyriphos	Dimethoate	Emamectin benzoate	Ethion	Fenpropathrin	Imidacloprid	Lambda cyhalothrin	Monocrotophos	Profenophos	Phosalone
1.	-	**0.071**	-	-	-	-	-	-	-	**0.175**	-	-	-	-	-
2.	-	-	-	-	**0.056**	-	-	-	-	-	-	-	-	-	-
3.	-	-	-	-	-	-	-	-	-	**0.037**	-	-	-	-	-
4.	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.092**	-
5.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6.	-	-	**0.163**	-	-	-	-	-	-	-	-	-	-	-	-
7.	-	-	-	**0.083**	-	-	-	-	-	-	**0.097**	-	-	-	-
8.	**0.012**	-	-	-	-	-	-	-	-	-	**0.114**	-	-	-	-
9.	-	-	-	-	-	-	-	**0.027**	-	-	-	-	-	-	-
10.	-	-	-	-	-	**0.076**	-	-	-	-	-	-	-	-	-
11.	-	-	-	-	**0.011**	-	-	-	-	-	-	-	-	-	-
12.	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.578**	-
13.	-	-	**0.032**	-	-	-	-	-	-	-	-	-	-	-	-
14.	-	-	-	-	-	-	-	-	-	-	**0.065**	-	-	-	-
15.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16.	**0.09**	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17.	-	-	-	-	-	-	-	-	-	**0.241**	-	-	-	-	-
18.	-	-	-	-	**0.092**	-	-	-	-	-	-	-	-	**0.071**	-
19.	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.094**	-
20.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21.	-	-	-	-	-	-	**0.032**	-	-	-	-	-	-	-	-
22.	-	-	-	-	-	-	-	-	-	**0.120**	-	-	-	-	-
23.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24.	-	-	-	-	**0.057**	-	-	-	-	-	-	-	-	-	-
25.	-	-	-	-	-	-	-	-	-	-	-	**0.080**	-	-	-
26.	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.040**	-
27.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28.	-	-	**0.197**	-	-	-	-	-	-	-	-	-	-	-	-
29.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.012**
30.	-	-	**0.074**	-	-	-	-	-	-	-	-	-	-	-	-

phosalone(0.012 mg/kg).Though there is no codex MRL available for curry leaf, there are three pesticides namely profenophos (0.578 mg kg^{-1}), afidopyropen (0.197 mg kg^{-1}) and fenpropathrin (0.241 mg kg^{-1}) having a high residue (Table 5)**.**

From the present study, it is found that the adoption of intensive cultivation practices and the introduction of improved varieties result in high pest problems and significant losses in the quality of the produce. Since curry leaf is grown as a commercial crop in the region, farmers depend on pesticides as a solo method for compacting insect problems for getting quality foliage. Considering the knowledge gap identified and the higher proportion of samples showing traces of pesticide residue the farmers in this region need to be sensitized on various IPM options available for curry leaf pest management and the sensible use of insecticides. So that the curry leaf harvest in this region can be made pesticide-free.

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