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Methods for Reduction of Organophosphate Residues from Brinjal

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A B S T R A C T

The study was conducted in brinjal to observe the reduction percentage of acepahte, profenophos, triazophos and ethion when they were sprayed double the recommended dose of the above mentioned OP's at field. The decontamination of acepahte, profenophos, triazophos and ethion was observed in the range of 21.20-72.32, 35.02-85.81, 38.20-78.19 and 31.36-83.03 percent respectively. Treatment T_3 (dipping in 2% brine solution) was found significantly better than rest of the treatments in decontamination of profenophos, triazophos and ethion which resulted in 85.81, 78.18 and 83.03 % loss respectively. Acephate was reduced in maximum amount (72.32%) by T_8 treatment (microwave treatment), which was at par with T_3 (dipping in 2% brine solution).

Key words: Decontamination, Organophosphates, Residue, Brinjal

India is the world's second largest producer of brinjal, after China. India produces about 7.676 million metric tonnes of brinjal from an area of 0.472 million hectares with an average productivity of 16.3 million tonnes per hectare. It is estimated to cover about 8.14% vegetable area with a contribution of 9% of total vegetable production (Sharma *et al.* 2018). Brinjal is one of the most common tropical vegetables grown in small plots or as inter crop both for cash and domestic consumption by farmers all over India. A large number of cultivars differing in size, shape and colour of fruits are grown in India. Immature fruits are used in curries and a variety of dishes are prepared out of brinjal. Fruits are moderate sources of vitamins and minerals like phosphorous, calcium and iron and nutritive value varies from variety to variety. Brinjal holds an area of 668.72 ha (000*) and its production is 12399.9 (000*MT) (Anonymous 2017). Supplies are adequate, but yields suffer from extensive insect damage, despite heavy and frequent insecticide applications. Brinjal fruit and shoot borer are the major insect pests and cause serious damage to yield. Farmers use variety of pesticides, of which organophosphates and synthetic pyrethroids are predominant and they don't follow the recommended dose for spray. Moreover, farmers are not looking at the safety intervals while harvesting the Brinjal thus resulting in pesticide residues in Brinjal at both farm gate and market points. Therefore, in order to study the residue level at the farm gate and market points an experiment was conducted at AINP-Pesticide residue, Anand Agricultural University, Anand, Gujarat.

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MATERIALS AND METHODS

The particulars of materials used during the course of investigation and methods adopted in conducting the present study entitled 'Methods for reduction of Organophosphate residues from Brinjal'. Decontamination study of organophosphate pesticides by different household processing methods (washing, dipping, cooking and ozone treatment) in brinjal. An experiment was conducted at AINP on Pesticide Residue laboratory, AAU, Anand (Gujarat) to study the decontamination of profenophos, acephate, triazophos, and ethion in vegetable samples. Vegetable samples were collected from the plot treated with pesticides, followed by various decontamination treatments. The samples were then analyzed at Pesticide Residue Laboratory for the possible losses of pesticides. The experiment was carried with three replications along with an absolute control treatment.

Design	:	Completely randomized design
Location	:	AINP on pesticide residues, AAU, Anand

Year	:	2017
Pesticides sprayed	:	1. Profenophos 50EC (0.2% a.i based) 2. Acephate 75 SP (0.25% a.i based) 3. Triazophos 40 EC (0.1% a.i based) 4. Ethion 50 EC (0.3% a.i based)
Number of repetitions	:	3
No. of treatments	:	9

Treatment details

No. of treatments: 9

T_0: Treated control

T_1: Washing under running tap water for two minutes

T_2: Dipping in tap water for 10 min + T_1

T_3: Dipping in 2% brine solution for 10 min + T_1

T_4: Dipping in 0.5% acetic acid solution for 10 min + T_1

T_5: Dipping in 0.1% $KMnO_4$ solution for 10 min + T_1

T_6: Ozonation for 15 min

T_7: Dipping in 0.1% $KMnO_4$ and ozonation for 15 min + T_1

T_8: Microwave treatment for 2 min

Suitable vegetable plants were sprayed with double the recommended dose of the following pesticide profenophos 50EC (0.2% a.i based), acephate 75 SP (0.25% a.i. based), triazophos 40EC (0.1% a.i. based) and ethion 50 EC (0.3% a.i. based) in the field at Main Vegetable Research Station AAU, Anand. The fruit samples were collected from field after 24 hours of the spray. The samples were kept at room temperature for further 24 hours. Experiment was carried out at AINP on pesticide residue laboratory, AAU, Anand.

Insecticide application

Required spray solution of four organophosphate pesticides viz. profenophos (50EC), acephate (75SP), triazophos (40EC) and ethion (50EC) were prepared. The required quantity of organophosphate pesticides application was calculated using the following formula:

$$N_1V_I = N_2V_2$$

Where,

N_1 = Pesticide available trade formulation

V_1 = Volume of pesticide to be required (mL or g)

N_2 = Double recommended solution

V_2 = volume of water (10 L.)

Accordingly, the required quantity of organophosphate formulation was determined by the formula for organophosphate treatments. The calculation of different doses is as under.

Table 1 Different doses of insecticides

Technical name of insecticide	Trade name and formulation of insecticide (N_1)	Application rate		Quantity of insecticide required in g or mL (V_2)
		Double the recommended dose (N_2)	Quantity of water (V_1)	
Profenophos	Curacron (50% EC)	0.2 % a.i.	10L	40
Acephate	Orkum (75% SP)	0.25 % a.i.	10L	30
Ethion	Fosmite (50% EC)	0.3 % a.i.	10L	60
Triazophos	Trizocel (40%) EC	0.1 % a.i.	10L	25

Collection of vegetable samples

For residue analysis brinjal samples (2 kg) were collected from field after 24 hours of the spray. Samples were kept at room temperature for further 24 hours, after that it was taken for treatments.

Decontamination treatments

Decontamination treatment was carried out in laboratory by different treatments followed by drying at room temperature. Procedures were accomplished either by different washing solution, ozonation and microwave exposure to evaluate their effectiveness on removing such residues.

Methodology

Required solution of all the four organophosphate pesticides at double the recommended dose (a.i. based) was prepared, and sprayed over the vegetable crops. The vegetables samples were collected from field after 24 hours of spray and kept at room temperature for further 24 hours. For treated control i.e. T_0: 250 g of each commodity was taken immediately for the determination of residue level of pesticides before the treatments. The remaining commodity was divided into eight parts, each containing 250 g of the vegetable.

Washing treatment: The vegetable samples were dipped in a jar for 10 minutes filled with aqueous solutions, 0.1% $KMnO_4$, 0.5% acetic acid, 2% brine and tap water individually as separate treatment. This was followed by running tap water treatment for 10 min with gentle rotation by hands. The samples were allowed to dry on the blotting paper at room temperature under fan.

Ozonation: Commercially available ozonator was used for ozonation of pesticides treated vegetable samples for the period of 15 minutes as suggested by manufacturer. This ozone treatment was given at concentration of 400 mg h^{-1} in 2 liters water.

$KMnO_4$ cum Ozonation treatment: Vegetable samples were dipped in 2 L of 0.1% $KMnO_4$ solution for 15 min along with, ozonation treatment.

Microwave treatment: The selected vegetable samples were subjected to microwave oven treatment for 2min to study the pesticide losses.

Method of analysis

Tests	Instruments	Reference
Pesticides	GLC-FPD	QuEChERS AOAC (2007)

RESULTS AND DISCUSSION

The data regarding decontamination of residues in brinjal due to different treatments are presented in (Table 2) and graphically depicted in (Fig 1) the residues of acephate were significantly reduced by different decontamination treatments. The reduction in acepahte residues in brinjal fruits due to various treatments ranged from 21.20 to 72.32 percent. The data revealed that treatment T_8 (microwave exposure for 2 min) resulted in maximum reduction (72.32%) of acephate, which was at par with T_3 treatment (dipping in 2% brine solution followed by washing under running tap water for 2 min) showing 67.38% reduction. The next best treatment was T_4 (dipping in 0.5% acetic acid solution followed by washing under running tap water for 2 min) which resulted in in 64.99% reduction of acepahte, however it was at par with treatment T_5 (dipping in 0.1% $KMnO_4$ solution followed by washing under running tap water for 2 min). Ozonation and in combination with 0.1% $KMnO_4$ dipping showed only moderate reduction of acephate (42.55-45.56%) as treatment T_6 and T_7 were at par. Dipping in tap water (T_2) showed only 32.15 percent reduction in acepahte whereas washing under tap water (T_1) revealed the minimum reduction of 21.20 percent.

The magnitude of reduction of profenophos residues in brinjal fruits due to different treatments ranged from 35.02 to 85.81%. The maximum reduction (85.82%) of profenofos residues was found in T_3 treatment (dipping in 2% brine solution followed by T_1) followed by T_4 treatment (dipping in 0.5% acetic acid solution followed by T_1) which resulted in 85.15 percent reduction and were found at par with each other. The next best treatment was T_5 (dipping in 0.1% $KMnO_4$ solution) resulted in 79.84 percent reduction which was found at par with T_7 treatment. Microwave reduction 35.02 per cent was found in treatment T_1 (washing under running tap water for two minutes).

The magnitude of reduction of ethion residues in brinjal fruits due to different treatments ranged from 31.36 to 83.03 per cent. Significantly higher reduction (83.03%) of ethion was found in T_3 treatment (dipping in 2% brine solution followed by T_1) followed by T_4 treatment (dipping in 0.5% acetic acid solution followed by T_1) which resulted in 82.13 per cent reduction of residues and both the treatment were found at par. The next best treatment was T_5 treatment (dipping in 0.1% $KMnO_4$ solution for 10 min followed by T_1) which reduced 75.90% of ethion residues. Moderate reduction were observed in T_6 treatment (ozonation for 15 min) and T_7 treatment (simultaneous dipping in 0.1% $KMnO_4$ and ozonation). The least degradation was observed in treatment T_1 (washing under running tap water) which was 31.36 percent.

Table 2 Reduction of organophosphate residues from brinjal

Residue (µg g^{-1}) / Treatments	Acephate			Profenophos			Ethion			Triazophos		
	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z
T_0: Control	1.297	-	-	7.309	-	-	8.346	-	-	2.659	-	-
T_1: Washing under running tap water for two min	1.022	0.275	21.20	4.749	2.56	35.02	5.729	2.617	31.60	1.355	1.304	49.04
T_2: Dipping in tap water for 10 min followed by T_1	0.880	0.417	32.15	4.383	2.92	39.95	5.063	3.283	39.33	1.364	1.295	48.70
T_3: Dipping in 2% brine solution for 10 min followed by T_1	0.423	0.874	67.38	1.037	6.272	85.81	1.416	6.93	83.03	0.580	2.079	78.19
T_4: Dipping in 0.5% acetic acid solution for 10 min followed by T_1	0.454	0.843	64.99	1.085	6.224	85.15	1.491	6.855	82.13	0.654	2.005	75.40
T_5: Dipping in 0.1% $KMnO_4$ solution for 10 min followed by T_1	0.524	0.773	59.60	1.473	5.836	79.84	2.011	6.335	75.90	0.777	1.882	70.77
T_6: Ozonation for 15 min	0.719	0.578	44.56	1.875	5.434	74.35	2.721	5.625	67.39	0.808	1.851	69.61
T_7: Dipping in 0.1% $KMnO_4$ solution for 10 min followed by T_1	0.745	0.552	42.55	1.550	5.759	78.79	2.540	5.806	69.57	0.861	1.798	67.62
T_8: Microwave treatment for 2 min	0.359	0.938	72.32	2.734	4.575	62.59	4.408	3.938	47.18	1.643	1.016	38.20
S.Em. ±		0.02			0.04			0.04			0.02	
CD		0.07			0.13			0.13			0.07	
CV (%)		7.11			3.31			2.49			4.00	

The magnitude of triazophos reduction ranged from 38.20 to 78.19 percent in brinjal fruits due to different treatments. Significantly higher reduction (78.19%) of triazophos was found in T_3 treatment (dipping in 2% brine solution followed by T_1) followed by T_4 treatment (dipping in 0.5% acetic acid solution followed by T_1) which resulted in 75.40% reduction of residue. T_3 treatment was found at par with T_4 treatment. The treatment T_6 (ozonation for 15 min) and T_7 (dipping in 0.1% $KMnO_4$ followed by T_1) were found equally effective in reduction of residues. Treatment T_1 (washing under running tap water) and T_2 (dipping in tap water) showed moderate reduction of triazophos. The least

reduction was recorded in microwave treatment (T_8). The result of decontamination of residues in brinjal revealed that treatment T_8 (microwave treatment) and T_3 (dipping in 2% brine solution for 10 min followed by washing under running tap water) were found to be the best treatments in reducing the residues. Acephate is a keto-amide ester of organophosphate which is more prone to degradation due to hydrolysis in alkaline condition and at higher temperature. This could be the reason that treatments T_8 and T_3 were more effective in removing acephate from brinjal. Nagayama (1966) also observed reduction in OP's due to cooking.

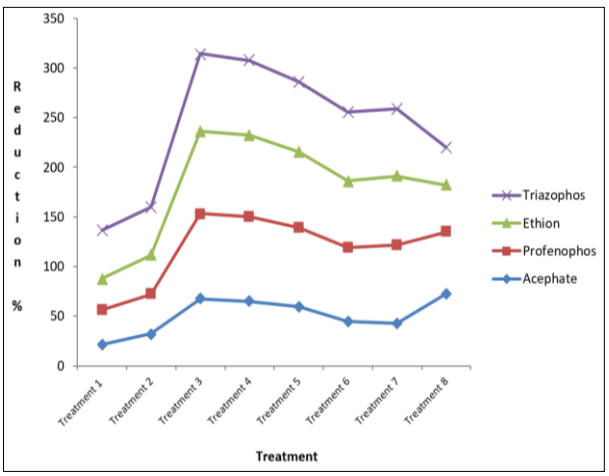

Fig 1 Overall view of reduction in pesticides

The reason for removal of profenophos, triazophos and ethion residues by dipping in 2% brine solution for 10 min followed by washing under running tap water for 2 min could be due to the fact that most of these residues are present at the surface of the sample and it is easy to remove by simple washing. Moreover, the more alkaline the water, the more rapidly the pesticides break down. The hydrolysis fastened up as the pH became more alkaline. Liang *et al.* (2012) reported reduction in the residues of certain organophosphate insecticides in cucumber when dipped in 2% sodium chloride solution for 10 min. The results in the present investigation about the decontamination of pesticides from brinjal fruits are in conformity with Parmar *et al.* (2012) who reported considerable dislodging of organophosphate pesticide residues while in washing with 2% brine solution. The present investigation is also in agreement with earlier reports of Dhiman *et al.* (2006), Ling *et al.* (2012), Raveendranath *et al.* (2014).

Dipping in 2% brine solution for 10 min followed by washing under running tap water was found the most effective treatment for reduction of profenophos, triazophos and ethion in brnjal upto 85.81%. Dipping in 0.5% acetic acid for 10 min followed by washing under running tap water was found the next best treatment for reduction of profenophos, triazophos and ethion. Treatment T_8 (microwave fro 2 min) was found the most effective in degradation of acepahte up to 72.32% and the second-best treatment was dipping in 2% brine solution followed by washing under running tap water. Washing the brinjal fruits under running tap water for 2 min was found least effective for removal of profenophos, acepahte and ethion whereas microwave for 2 min had the least effect in removal of triazophos.

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