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Residual study of monocrotophos on okra (*Abelmoschus esculentus* L. Moench)

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Abstract
Okra an important crop attacked by many insect pests, insecticides are widely used tool to manage these insect pests besides, their great role in managing population of insect pests their harmful residues left on the end products. Therefore, the present study on residue dynamics of monocrotophos on okra crop was carried out. Field was sprayed with monocrotophos 36SL at the rate of 0.350 and 0.700 gm. a.i. /ha. Samples were collected from field and carried to laboratory to study the dissipation of monocrotophos on fruits and leaves of okra by GLC after 0, 1, 3, 5 and 7days of treatment. Total recovery of Monocrotophos was observed to be 90%, 89% and 95% at 0.1, 0.5 and 2.5mg/kg fortified fruit samples, respectively. Dissipation was faster on leaves at double dose as compared to normal dose, while on fruits dissipation was faster at normal dose compared to double dose. Dissipation of pesticide was found to be faster on leaves compared to fruits. The half-life of the insecticide ranged between 1.92 and 2.08 days on fruits and 1.18 and 1.02 days on leaves. Waiting period of 7.37 days for normal dose and 8.45 days for double dose was recommended. Okra crop require harvest every 3-4 days due to its fast growing habit. While dissipation rate of Monocrotophos is slow the findings of experiment led to the conclusion that application of Monocrotophos should be restricted for use on okra.

Keywords: Monocrotophos, residue, okra, dissipation, maximum residue limit, half-life

Introduction
Okra (*Abelmoschus esculentus* L. Moench, Family –Malvaceae), is an important vegetable crop grown for its edible pods in many parts of the different countries. Its fruits are rich source of many required nutrients viz. Vitamins, Carbohydrates, Minerals (Fe, Mn, Zn, Ni, Ca, Mg, K) and Fats etc. to human body. Although, the cooked fruits of okra are served as vegetable, okra leaves are taken as raw for salad, or cooked like greens of beet. Okra seed oil is edible [10] and also used as biofuel. It is also used in medicines due to rich source of vitamins (A, B, C) and minerals (Fe, Ca, P). Okra crop is generally known by the name of bhendi in India and ladies finger or ochro in many English speaking countries. This crop is widely grown in Asia and according to Indian horticulture database India ranks first in okra production [1]. India export 60% of its total produces [16]. India produced 6145.97(000 Mt) okra from 528.37(000 ha) area under cultivation during 2016-2017 [2]. West Bengal, Gujarat, Bihar, Odisha, Madhya Pradesh and Jharkhand are leading producer states of India [2]. Insect pests are the major constraints for the production of okra crop [12] and about 28 species of pests were found to be damaging this crop [4, 13]. Major insect pests include leaf miner (*Liriomyza trifolii*), flea beetle (*Phyllotreta downsei*), jassid (*Amrasca biguttula biguttula*), white fly (*Bemisia tabaci*), aphid (*Aphis gossypii*), mealy bug (*Ferrisia virgata*), red cotton bug (*Dysdercus cingulatus*), shoot and fruit borer (*Earias vittella*), green stink bug (*Acrosternum hilare*), painted bug (*Bagrada cruciferarum* [B. Hilaris) and a grasshopper [15]. The insect pests caused 49.30% mean reduction in fruit yield [11] and fruit borer damage caused 28.45% yield loss in okra [6]. Insecticides are the important tools to manage insect pests of this crop. Besides their effectiveness, the insecticides pose a major health hazard to the human beings [9]. Pesticide residues have a detrimental impact on the human health [8]. Okra is a fast growing vegetable and requires harvesting every 3rd to 4th day, therefore, to ascertain the amount of monocrotophos residues on the okra fruits and leaves, the present experiment was conducted.

Materials and Methods
A field experiment was carried out at the entomology farm of Dr. Y.S.P. University of Horticulture and forestry, Solan, Himachal Pradesh. Okra crop was sown on bed area of 5

x4m^{2,} spaced 45 cm row to row and 15cm plant to plant following the package and practices as per university recommendations for normal crop growth. Monocrotophos 36SL insecticide was sprayed at the rate of 0.350 and 0.700kg a.i. /ha and each dose replicated three times. Samples were drawn at -0, 1, 3, 5 and 7days after treatment to study the dissipation of Monocrotophos on okra fruits and leaves which were carried to laboratory for residue analysis.

Residue analysis

The 50gm sample of fruits and leaves was blended in a blender for 2 minutes in 150ml, 100ml and 100ml portions of acetone. Three extract samples were filtered through Buchner funnel using watman's No.1 filter paper with the help of vacuum pump. After that acetone extract was concentrated in Flash evaporator, diluted with 250 ml of 2% sodium sulphate solution containing water in a separating funnel. This aqueous layer was partitioned thrice with 50 ml of hexane. The hexane phase was discarded. The hexane phase was again partitioned thrice with 50 ml of chloroform. Chloroform phase dried over anhydrous sodium sulphate after discarding aqueous phase. Concentrated chloroform extract removed from flasks by adding distilled ethyl acetate 2-3 times and concentrated. Residue was taken in 25ml distilled ethyl acetate for GLC analysis. The 50 g of okra fruits were fortified at three levels (0.1, 0.5 and 2.5 mg/kg) and each level replicated thrice. The residues were detected by using Gas Liquid Chromatography (GLC). The GLC parameters were: Model-HP5890A, Oven temperature-150^{0}C 5min@ 20^{0}C /min- 190^{0}C- 5min, Injection temperature 240 ^{0}C, Detector temperature-300 ^{0}C, Column-OV-17, N_2 flow-30 ml/min, H flow- 1ml/min.

Results

The monocrotophos 36SL@ 0.350 Kg a.i. /ha and 0.700 kg a.i. /ha was evaluated for residue dynamics on fruits and leaves of okra. Crop and data is presented in table 1, 2 and 3. On an average monocrotophos was recovered 90%, 89% and 95% at 0.1, 0.5 and 2.5 mg/kg fortified fruit samples respectively (Table 1). The results of residue analysis of Monocrotophos 36 SL in okra fruits and leaves at 0.300 and 0.700 kg a.i/ha and the percent dissipation of residues are presented in Table 2 and 3. Monocrotophos at the rate of 0.350kg/ha gave a deposit of 2.856 mg/kg which dissipated to 0.217 mg/kg showing a decline of 92.4% and when applied at the double dose (0.700kg/ha) a deposit of 3.677mg/kg was observed which dissipated to 0.326mg/kg showing a decline of 91.13% in 7days on okra fruits. The half-life of the insecticide for the two doses was 1.92 and 2.08 days respectively on fruits. On leaves a deposit of 15.270 mg/kg and 27.793 mg/kg was observed at the two doses which dissipated to 0.353 (44%) mg/kg and 0.305 (90%) mg/kg in 7 days with half values of 1.16 days (0.350kg a.i./ha) and 1.02 days (0.700kg a.i./ha).

Table 1: Recovery of Monocrotophos on okra fruits at different fortified doses.

Amount fortified (mg/kg)	Amount recovered mg/kg	Total recovery%
0.1	0.090	90
0.5	0.446	89
2.5	2.76	95

Table 2: Recovery of Monocrotophos on okra fruits at different fortified doses.

Days after application	Monocrotophos 0.350kg a.i./ha		Monocrotophos 0.700kg a.i./ha	
	Residue* (mg/kg)	Percent dissipation	Residue* (mg/kg)	Percent dissipation
0	2.856 ± 0.203	--	3.677 ± 0.123	---
1	2.161 ± 0.293	24.3	3.094 ± 0.019	15.86
3	0.921 ± 0.174	67.70	2.605 ± 0.175	29.15
5	0.577 ± 0.162	79.80	0.898 ± 0.145	75.58
7	0.217 ± 0.008	92.40	0.326 ± 0.022	91.13

*Average of three replications.

Correlation coefficient r= -0.984.Regression equation Y= -0.540-0.157x. RL50= 1.92 days (0.350kg a.i. /ha).

Correlation coefficient= -0.952. Regression equation Y= -0.676-0.145x. RL50= 2.08 days (0.700kg a.i. /ha).

Table 3: Dissipation for different doses of monocrotophos on okra leaves.

Days after application	Monocrotophos 0.350kg a.i./ha		Monocrotophos 0.700kg a.i./ha	
	Residue* (mg/kg)	Percent dissipation	Residue* (mg/kg)	Percent dissipation
0	15.270± 2.411	--	27.793 ± 1.240	---
1	10.175 ± 1.935	29.83	24.429 ± 0.462	12.10
3	5.337 ± 0.883	65.05	8.909 ± 0.347	67.94
5	0.641 ± 0.064	95.80	0.743 ± 0.113	97.33
7	0.353 ± 0.038	97.69	0.305 ± 0.049	98.90

*Average of three replications.

Correlation coefficient r= -0.975.Regression equation Y= -1.357-0.259x. RL50= 1.16 days (0.350kg a.i. /ha).

Correlation coefficient= -0.979. Regression equation Y= -1.614-0.296x. RL50= 1.02days (0.700kg a.i. /ha).

Discussion

Initial deposit of monocrotophos depends upon a number of factors like concentration, weather conditions, substrate characteristics, type of sprayer used, distance between nozzle and plant surface and properties of carrier etc. Persistence of deposits is influenced by environmental factors such as light, temperature, relative humidity, precipitation etc. Average maximum temperature was 28.2^{0}C and average minimum temperature was 19.8^{0}C, average relative humidity was 80.44%, average sunshine hours were 7.9 and total rainfall during the experimental period was 63.6mm.

The half-life value of the insecticide on okra fruits was found to be 1.92 and 2.08 days respectively for single and double dose. The first half of the deposit of monocrotophos on okra leaves dissipated in 1.16 and 1.02 days for single and double dose. The deposit of the insecticide on fruits at normal dose (0.350 a.i. /ha) was 1.3 times lower than that at double dose (0.350 a.i. /ha) while on okra leaves 1.5 fold increases in deposit was observed when the dose was doubled. Similar findings were reported [7, 18] where 1.0-1.9 fold increase of the

deposit was observed when dose was increased from 0.03-0.05 and then to 0.07% on okra fruits. Similarly 1.25 times higher deposits were recorded at double dose over the recommended one [14] with a half-life value of 1.99days and a waiting period of 8.55 days on cabbage. The results on leaves are in fair agreement [3, 18] of finding shown 1.1-2.9 fold increase in the deposit of Monocrotophos when the dose was increased from 0.03%-0.05% and to 0.07% in a four spray schedule and 0.350 to 0.700 kg a.i./ha in the two spray schedule. Similar trend (1.65 fold increase) was observed at 157.32 and 314.64 gm a.i. /ha application of Monocrotophos on caster [5]. The result on fruit showed similarity of RL50 values [14, 18] found that the normal dose dissipate faster compared to higher dose. However [3] found two doses to dissipate at equal rate. In general the results indicated that first half of Monocrotophos deposit dissipated faster on leaves compared to fruits. This could be probably due to the translocation of the systemic Monocrotophos from leaves either to fruits or to freshly emerging shoots. Minimum temperature was found responsible for degradation of monocrotophos [17]. In the present investigation 20^0C temperature seems to influence the faster reduction of monocrotophos residues. The waiting period for monocrotophos was found to be 7.37 and 8.45 days respectively, for single and double dose treatment. Findings are lower than obtained [7] on okra (13.7-18.3 days). Result shows close approximation with [18] 6.78 and 11.25 days withholding period at 0.05 and 0.07% monocrotophos application. These waiting periods are higher because of the fast growing habit of okra fruits which require harvest every 3-4 days. Hence, monocrotophos should be restricted for use on okra.

Conclusion

Finding of the experiment revealed that the waiting period for harvesting okra fruit was 7.37 days for normal dose and 8.45 days for double dose. Okra fruits require harvest every 3-4 days due to their fast growing habit. Therefore, application of Monocrotophos should be restricted for use on okra.

Significance statements

Monocrotophos is an effective insecticide to manage insect pest population of various crops. But it has a longer residual life on okra fruits and leaves which would be detrimental to human health after consumption as this is a very swift growing fruit and requires to be harvested after every 3 days. Therefore, application of monocrotophos should be restricted for use on okra crop.

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