Original Research Article

Assessment of the Barrier Performance of the Flourosilicone Treated Fabric Exposed to Pesticides Spraying to Chilli Crop at Laboratory Conditions

Abstract

In this study, in view of development of protective clothing for pesticide sprayers in chilli crop, the suitable fabric polyester 67/cotton 37 with weight 157.7 GSM was selected. BOND-WR-12-A RTU is an aqueous fluorosilicone durable water and oil repellent emulsion was used to treat the fabric by using different application parameters at the rate of 5 per cent concentration. As per Chowdhury, 2018 water repellent finish type and concentrations were very important parameters to obtain water repellent fabric having acceptable use properties. Later, the treated fabric was exposed to three selected pesticides for three exposures of Phosphamidon, Monocrotophos and Dimethoate. By estimating the absorption and penetration behaviour of the treated and untreated fabrics, the performance of silicon finish was determined by using four factor with CRD and Heuristic method. From this result, the treated fabric had restricted the absorbency over control fabric and the Studies on barrier clothing, (Padma and Khateeja, 2017; Rani *et al.,* 2017) suggested that blends of polyester cotton and polyester viscose showed better barrier performance with minimum penetration of pesticides than other blended fabrics. Hence it can be used in developing of protective clothing for pesticide applicators in chilli crop or any other field crops where ever pesticides are used.

Key words: *Pesticides, absorption, chilli crop, penetration, barrier performance, laboratory exposure*

Introduction:

Chilli crop is one of the major food additive crop among all commercial crops in India. India is one of the country to cultivate the chilli crop majorly. This crop is sprayed number of pesticides which are harmful to human beings and animals Embrandiri et al., 2012 to manage the pests and diseases during the entire period of crop. In this context, the only applicator frequently exposed to pesticides to an extreme levels. Farmers use different plant protective chemicals to meet the high quality and quantity of crop yield. It was also indicated Andhra Pradesh is one of the country's largest pesticide users (Kumari,2022). In this context, majority of farmers/workers (pesticide applicators) are being exposed to different plant protection chemicals knowingly or un-knowingly who are involved right from sowing to harvest and storage of chillies (Rajee and Sapna, 2018).

It was observed that chilli crop is sprayed with a variety of pesticides and insecticides to manage pests and diseases. This extensive use of pesticides is a serious

concern as there are various acute and chronic health problems that are encountered due to the exposure of farmers, who are involved in mixing, or when applying pesticides or when working in treated fields. Kori *et al.* (2018) assessed the adverse health effects among chronic pesticide-exposed farm workers. That adverse health effects were found in farm workers viz., tingling (32.3%), muscle pain (51.6%), headache (56.5%), skin disease (19%), blurred vision (35.5%), tremor (23%), stress (24.2%), depression (15.3%), anxiety (44.7%), altered taste (21.4%), altered smell (31.4%), sleep disorder (39.5%), dizziness (66.1%), memory problems (29.4%), trouble in walking (8%), and cardiac problems (16.9%). A better option to against pesticides exposure is water repellent fabric is essential to construct barrier clothing to applicators. Hence in this study to get better" barrier fabric, the treated fabric had been exposed to laboratory exposure with pesticides and studied the barrier performance of control and treated fabrics through estimation of the pesticide residues absorbency and penetration by using Gas chromatography.

Polyester 67/cotton 33 (Padma and Khateeja, 2017) with 157.77 GSM woven fabric which was desized in acid (Karmakar, 1999) method by using soft flow dyeing machine was used to apply the water repellent Fluorochemical finishing as per Chowdary, 2018 finish (BOND-WR-12A (RTU)) with 5% concentration at required finishing parameters viz., drying temperature 105., drying time 3 minutes., curing temperature 165 (Sayed and Dabhi, 2014) curing time 3 minutes and PH 5. Test fabrics treated with fluorosilicone compound were exposed to pesticide formulations used by the applicators in the same dilution used for chilli crop. This was done to simulate field conditions of spraying. By estimating the absorption and penetration behaviour of the fabric, the performance of silicon finish was determined. Conditions of exposure of fabrics to pesticides and drying were same for all fabrics. Pesticide solution as used in the laboratory conditions (2ml/l) for all three selected pesticides- Phosphamidon, Monocrotophos and Dimethoate was used in this test. Test fabric sample was cut with 15 cm x 15 cm diameter. On this sample, 8 x8 cm square was marked in the centre. Whatmans paper of similar size was also cut and a square was marked in the centre as that of fabric. Fabric sample was placed on the paper coinciding the 8x8 cm square. The prepared specimen was backed with aluminum foil of similar size. This foil does not allow pesticide to pass through the absorbent paper. A total of 9 specimens were

prepared from polyester/cotton finished fabric to estimate the absorption and penetration of all the 3 pesticides for 3 exposures. Hand sprayer was used to spray pesticide solution. It was sprayed within the marked 8 cm square in all 9 specimens for three times uniformly. Specimens were allowed to dry for an hour and the 8 cm square was cut in specimens. First set of 3 fabric specimen after single spray and their absorbent paper specimen were transferred into separate glass containers for further study. Solvent Hexane was added to the containers so as to wet the samples for extraction of pesticide residue. Containers were labelled and stored for analysis. The second and third set of specimens was sprayed for the second time with pesticides. The second set of specimens were dried and transferred into separate containers. The third set was sprayed for the third time and these were also transferred into separate labelled containers.

Method

All fabric samples and absorbent papers collected from laboratory and soaked in 30 ml of hexane, overnight in separate cleaned glass bottles with lids. The contents were shaken thoroughly and filtered through Whatman No.1 filter paper. A second and third collection was done after adding 10 ml of hexane each time and shaking the bottles to obtain the maximum residue from the samples. All three extractions were mixed and finally filtered extract was then evaporated completely

Agilent 7010B Gas Chromatography was used for analyzing pesticide residue extractions from the exposed untreated, filter papers and treated fabric samples. One µl of the extracted solvent of each sample was injected with a 10 µl syringe and analysed for the quantification of pesticides presented in samples were expressed as ng/cm2 (nano-grams per square centimetre) of the fabric or 64 cm2 for 8 cm x 8 cm sample. Further, absorption and penetration of pesticide residues data were collected and compiled tabulated and statistically analyzed using four factor experimental with CRD.

Results:

Laboratory Exposure of Silicon Finished Fabrics to Pesticides

The selected three highly toxic pesticides used in chilli crop by applicators were studied in respect to their penetration on finished and PC1 fabric under laboratory

conditions (Naksata *et al.,* 2020). Phosphamidon, Monocrotophos and Dimethoate were sprayed on test fabrics to estimate the barrier performance of treated fabrics. Finished fabric showed a reduction of almost less than 50 per cent of chemical both in absorption and penetration for all three pesticides.

Results presented in tables 1 and 2 denotes the absorption and penetration behaviour of 3 selected pesticides - Phosphamidon, Monocrotophos and Dimethoate on both control and treated fabric exposed to laboratory spraying. The findings of the study after one exposure with three pesticides indicated that the fabrics with higher absorption exhibited lower penetration. The amount of -Monocrotophos residue absorbed and penetrated on control and treated fabric was highest (7.593 ng) followed by Dimethoate (7.168 ng) and Phosphamidon (5.751 ng). Both absorption and penetration values increased with repeated sprays both in control and treated fabrics.

However, it was observed that significantly higher (9.053 ng) absorption and penetration was noted on control fabric and lower (4.621 ng) absorption and penetration was identified on treated fabric. It may be noted that fluorocarbon finishes provided better protection against pesticide penetration and reduced wicking. Pooling up these findings, it could be inferred that the rate of absorption and penetration showed an increasing trend after each exposure indicating that there is a direct relation between exposure and absorption and exposure and penetration. However, the rate of absorption indicated an inverse relation with penetration.

As seen from table. 1, the percentage reduction of absorption and penetration in treated fabrics ranged from 42 to 57 over control indicated that treated fabric has performed its function of acting as a barrier to pesticides. It was stated by Das et al., (2016) that if the surface energy of the protective clothing is lowered substantially employing fluorochemical finish the clothing is reported to perform effectively for prevention of penetration of pesticide through them. Flurocarbon repellent finishes have been found to be excellent barrier finishes against pesticides.

Highest reduction in both penetration and absorption values were observed with Monocrotophos, one of the highly toxic chemicals of the three. Four-factor

experimental with CRD test data showed that there was a significant difference among three pesticides in their absorption and penetration through test fabric at 0.05 level.

From the above data it is evident that absorption and penetration of Monocrotophos was highest among the three pesticides. In order to compare the trend of the experimental values of the present study, Heuristic approach (Polya, 2014) was followed. Highest weightage value of 5 was given to Monocrotophos followed by Dimethoate with 3 and finally Phosphamidon with 2 based upon the values obtained. From the test results, highest value in both absorption and penetration of pesticide was rated as 5, followed by 3 and finally 2 for the least value for each spray. This is shown in table 1.

Table 1 Absorption and penetration of different pesticides on fabric under laboratory conditions

(Residues in ng/cm^2)

Pesticide	Absorption						Penetration					
	Control			Treated fabric			Control			Treated fabric		
	No. of sprays			No. of sprays			No. of sprays			No. of sprays		
	1	2	3	1	2	3	1	2	3	1	2	3
Phosphamidon	7.19	12.57	18.58	3.81 (47.01)	5.42 (56.88)	9.49 (48.92)	2.6	4.89	9.81	1.49 (42.69)	2.29 (53.17)	4.59 (53.21)
Monochorotophos	8.58	13.19	21.18	4.19 (51.17)	5.59 (57.62)	9.69 (54.25)	3.16	5.22	11.21	1.86 (41.14)	2.48 (52.49)	4.78 (57.36)
Dimethoate	7.39	12.89	19.48	3.88 (47.50)	5.47 (57.56)	9.38 (51.85)	2.92	4.98	10.56	1.56 (46.58)	2.45 (50.80)	4.76 (54.92)
Average of three exposures	9.053 (Control fabric)						4.621 (Treated fabric)					
Mean of sprays	One exposure (4.052), Two exposures (6.475) and Three exposures (9.984)											
**significant difference at the 0.05 level												

Value in the parenthesis indicate % decrease over control

Table 2 Heuristic model

Pesticide	Value allotted as per the Heuristic approach	Absorption						Penetration						Total
		Control			Treated fabric			Control			Treated fabric			
		No. of sprays			No. of sprays			No. of sprays			No. of sprays			
		1	2	3	1	2	3	1	2	3	1	2	3	
Phosphamidon	2	4	4	4	4	4	6	4	4	4	4	4	4	50
Monocrotophos	5	25	25	25	25	25	25	25	25	25	25	25	25	300
Dimethoate	3	9	9	9	9	9	6	9	9	9	9	9	9	105

The averages of each pesticide in terms of absorption and penetration in Heuristic approach indicated the highest influence of Monocrotophos, followed by Dimethoate and Phosphamidon.

Conclustion:

This study was concluded that the water repellent fabric showed better barrier performance over control to all three pesticides and three exposures. Here, increased absorption and penetration were observed with increased no. of exposures. However the penetration was low when compared to absorption in both control and treated fabric samples. But very low penetration was noticed in all treated fabric samples over control. However, the pertained results indicated that the water repellent treatment could entrap the absorption and penetration of pesticide residues to satisfactory levels over control. Hence, the repel fabric may useful as protective clothing contruction against pesticides exposure for appicators in chilli crop or any other pestiicdes spraying field crops.

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