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Performance of water repellent finish treated fabric against pesticides spraying at field conditions

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Abstract

To assess the performance of fluorosilicone treated fabrics towards pesticide spraying, test was conducted on subjects in farming situation. Patch method was followed in conducting the test. In this method, Polyester-Cotton (67:33) with 157.7 GSM was finished with BOND-WR-12 A RTU water repellent flour silicone finished patches of 8 x 8 cm were taken out from the treated fabric and the fabric sample patches placed in different areas on the sprayman's body over their regular attire. Pesticide residues collected from the exposed samples, estimated absorption and penetration with three pesticides individually and assessed treated and untreated fabrics exposed at different areas of the applicator's body after 3 different exposures. The field exposure study of Phosphomidon, Monocrotophos and Dimethoate pesticides were individually carried out in field conditions following Patch method (Garrigou *et al.*, 2008). The absorption and penetration was estimated through collected pesticide residues from treated and untreated fabric patches were analysed through Gas Chromatography. The study indicated that the mean residue of absorption and penetration was less in treated fabric samples over control fabric patches.

Keywords: fabric patches, absorption and penetration, fluorochemical

1. Introduction

Among the commercial crops, chilli is one of the main commercial additive crops of India. This country is one of the largest exporters and consumer of chilli with a production and productivity of 6.81 lakh hectares and 10.09 lakh tons respectively (Rajee and Sapna, 2018) [5]. Chilli crop is being cultivated by using superior and high yield varieties under extensive use of chemical fertilizers, repeated use of different pesticides and fungicides for timely management of pest and diseases. And it was observed that chilli crop is sprayed with a variety of pesticides and insecticides and sprayed twice or thrice a week during entire crop period i.e. 150-180 days. This extensive use of pesticides is a serious concern as there are different acute and chronic health problems that are encountered due to the exposure of farmers, who are involved in amalgamation or when applying pesticides. These health conditions range from a temporary irritation on skin, eyes, to reproductive and developmental disorders and fatality. Hence, to attain barrier properties, the P/C blend fabric was treated with water repellent finish for good barrier performance that offers right protection while wearing the clothes made with this fabric and to study the efficiency of the fabric in restricting the transmission of pesticide residue onto skin.

2. Material and methods

A Polyester-Cotton blended fabric which was suggested by Rajitha and Vatala, 2001 [6] showed less pesticide absorbency and penetration to skin. So that, the plain weave polyester-Cotton (67:33) with 157.7 GSM used for the study. After selection of fabric, desized by using acid method desizing which was developed by Karmarkar, 1999. Then, 5-10 ml/l of dilute sulphuric acid concentration had used to treat the fabric at 40°C temperature for 3-4 hours in 'Soft Flow Dyeing' (Fig. 1) machine and material to liquor ratio was reserved at 1:20. Further, the fabric was washed thoroughly under plain tap water. Then the BOND -WR -12-A RTU finish was applied on fabric in pad dry cure method at a finish conc. of 5%, at pH 4.5., wet pick up was maintained at 70%, drying temp. of 105°C, curing temp. Of 165°C and time for both drying and curing was same i.e. 3 min.

To assess the performance of finished fabrics towards pesticide spraying, Patchmethod was followed. In this method, patches with absorbent material of 8 x 8 cm were cut from the fabric treated with fluorochemical were placed directly on the applicator's clothing over his regular wear during spraying operation. These patches/fabric pieces are attached in the following locations: scalp region, on lower part of the knee and on the thigh, below the elbow and above the elbow, back of the neck (upper edge of the collar) and abdomen region (Soutar *et al.*, 2000) ^[7] (Fig. 2). After the exposure, fabrics were removed from the clothing, wrapped in aluminum foil separately, stored in polythene covers, and labelled. Labelled covers were placed in freezer until analysis was done. Samples were analyzed in GC for their absorption character. Further, the data was evaluated statistically by the method i.e. four factor experimental with CRD.



Fig 1: Soft flow dyeing machine



Fig 2: Field Exposure of test samples

3. Results and Discussion

4.5 Field Exposure of Finished Samples to Pesticides

The absorption of three pesticides on finished samples were measured by exposing the samples in the field situations.

Residues were extracted from the exposed patch samples and compared treated and untreated fabrics after 3 different exposures. Table- 1-3 shows the values of absorption of pesticide on the finish treated samples.

4.5.1 Absorption and Penetration of Phosphamidon

The amount of absorption and penetration of Phosphamidon in fabric patches placed on the body of applicator increased with repetition of sprays in field exposure both in control and treated fabrics. Fabric patches placed over different regions of the applicator's body significantly differed in their absorption and penetration values. This nonuniformity of pesticide on the body may be due to various factors such as climatic conditions, flow of air, plant height etc.

Among all fabric patches, lower absorption and penetration was reported on torso back and maximum value was found on the patch placed at the abdomen region in both control and treated fabrics after the third spray. Similar finding were noted by Cao *et al.* (2014) ^[1] that the primary exposure was on the front parts of the body, and the lower body parts were exposed more compared to upper body parts.

Reduced per cent of absorption and penetration was noticed in treated fabric patches on the body than control. In patches with control fabric, arm below elbow, legs above knee and abdomen region, the absorption and penetration of Phosphamidon was highest. All three areas had the same amount of absorption and penetration of pesticide after the third exposure.

A maximum decrease of 97.7 per cent in absorption was identified in the finished fabric patch placed at torso back and a least value of 14.3 per cent was seen in patch placed on legs below knee after 2nd exposure. The same tendency was observed in case of penetration of the pesticide in finished fabric patches. Following this were the patches at scalp region and arm below elbow region that had next higher percentage reduction in both absorption and penetration values of the pesticide.

Statistical analysis revealed a noteworthy differences between the test fabrics in the rate of absorption and penetration at different locations of the applicators' body.

Further, it was noted that the penetration and absorption significantly lowered in treated fabric than control. Because of the barrier performance of water repellent finish on the fabric. These findings are in conformation with result of Rajitha and Vastala, 2003 ^[6].

Fluorocarbon treated fabric patch placed on torso back recorded higher percentage of reduction of Phosphamidon pesticide over control. The absorption was reduced by 97.7 per cent and penetration by 97.5 per cent. Maximum barrier performance was observed in treated fabric even after the 3rd spray. Followed is, the patch on the scalp region which recorded next higher reduction both in terms of absorption and reduction. However, the reduction percentage reduced to nearly 53 per cent after the third spray which may be due to accumulation of pesticide in this region as spraying was continued to 3 long hour (Table 1). This is the area where additional protection layer of fabric was added in the garment which would answer the problem. Value in the parenthesis indicates % decrease over control.

Table 1: Absorption and penetration of Phosphamidon pesticide residue in fabric patches (Residues in ng/cm²)

Position of fabric patch on the body	Absorption						Penetration						Mean of fabric patch on the body part
	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	
Scalp	2.84	3.2	4.01	0.4 (85.92)	0.58 (81.88)	1.9 (52.62)	0.95	1.07	1.34	0.13 (86.32)	0.19 (82.24)	0.63 (52.99)	1.436
Arm-above elbow	3.1	4.2	5.5	0.8 (74.19)	0.89 (78.81)	2.9 (47.27)	1.03	1.4	1.83	0.27 (73.79)	0.3 (78.57)	0.97 (46.99)	1.932
Arm below elbow	4.54	5.98	7.6	0.98(78.41)	1.2 (79.93)	1.3 (82.89)	1.51	1.99	2.53	0.33 (78.15)	0.4 (79.90)	0.41 (83.79)	2.298
Torso front (abdomen)	6.2	7.58	7.8	1.6 (74.19)	2.4 (68.34)	4.5 (42.31)	2.07	2.53	2.6	0.53 (74.39)	0.8 (68.38)	1.5 (42.31)	3.342 *
Torso back (below shoulder level)	1.2	2.2	2.6	0.04(96.67)	0.05 (97.73)	0.08 (96.92)	0.4	0.73	0.87	0.01 (97.50)	0.02 (97.26)	0.03 (96.55)	0.685
Legs above knee	6.2	7.2	7.5	1.63(73.71)	2.3 (68.06)	4.1 (45.33)	2.07	2.4	2.5	0.54 (73.91)	0.77 (67.92)	1.37 (45.20)	3.215 *
Legs below knee	1.1	1.4	3.2	0.6 (45.45)	1.2 (14.29)	2.05 (35.94)	0.37	0.47	1.07	0.2 (45.95)	0.4 (14.89)	0.68 (36.45)	1.062
Average of three exposures	3.077 (Absorption)						1.004 (Penetration)						-
	3.021(Control)						1.060(Treated)						-
Mean of sprays	One (1.487), Two (1.936) and Three (2.698)												-

SEM: 0.006132

SED: 0.008672

C.D.: 0.017057

t 5% 336 dof = 1.967

(*) more significant

**significant difference at the 0.05 level

4.5.2 Absorption and Penetration of Monocrotophos

The trend of absorption and penetration of Monocrotophos in field trials on control and treated fabric patches showed similar pattern to that of Phosphamidon pesticide with higher residue as the number of sprays increased. This phenomenon was observed in both absorption and penetration of pesticide in both control and treated fabric. Both torso back and leg above knee regions recorded highest pesticide residue of absorption and penetration in control fabric while comparatively nearly 50% of the residue was observed in the arm below elbow region in control fabric in absorption and penetration.

There was great reduction in residue percentage in treated fabric patches over control. The highest percentage reduction observed for this pesticide was 87.6 in absorption and 87.6 in penetration; these both readings were found in patches placed in the head region of the applicator. Torso back and leg above knee regions had taken the next two places in reduction percentage of pesticide in treated fabric. At the end of 3rd spray, 55-65 per cent of pesticide reduction observed in these regions.

Monocrotophos pesticide residues were found higher in all fabric patches under field study compare to the other two

pesticides. This is extremely hazardous chemical among the three pesticides considered under study. The reduction per cent of pesticide in treated fabrics was also identified to be lower compared to the other two pesticides. Abdomen region and legs above knee region showed residue of 21.6 ng/cm² while the rest of five areas put together has amounted to 17.5 ng/cm².

Dermal absorption rates are based on a numerical scale in which the value of 1 for the forearm represents the lowest dermal absorption rate. That value figures the basis for assignment of values to the other body parts (Nesheim *et al.* 2017) [4]. In view of this, considering arm above elbow region to be standard, there was almost 2 ½ times more on abdomen region and thigh region of the applicator.

It was reported that leg exposure accounts to 72-75% of the total dermal exposure, and similar findings were reported by Cao *et al.* (2014) [11] that thigh and lower leg was the most contaminated parts, accounted approximately 76-88%. This was not found in the present study as pesticide was more in abdomen region and thigh region which may be due to heavy foliage and the height of chilli plant. The results of abdomen and thigh regions were statistically significant (Table 2).

Table 2: Absorption and penetration of Monocrotophos pesticide residue in fabric patches (Residues in ng/cm²)

Position of fabric patch on the body	Absorption						Penetration						Mean of three exposures of fabric patch on the body part
	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	
Head	3.86	4.2	5.85	0.48 (87.56)	0.76 (81.9)	2.05 (65.0)	1.29	1.41	1.95	0.16 (87.60)	0.25 (82.27)	0.68 (65.13)	1.912
Arm-above elbow	4.1	4.4	6.2	1.08 (73.7)	1.76 (60.0)	3.2 (48.4)	1.37	1.47	2.07	0.36 (73.72)	0.59 (59.86)	1.07 (48.31)	2.306
Arm-below elbow	5.69	7.2	8.5	1.28 (77.5)	1.86 (74.2)	4.2 (50.6)	1.9	2.4	2.83	0.43 (77.37)	0.62 (74.17)	0.62 (78.09)	3.128
Torso-front(abdomen)	10.8	10.82	11.6	2.1 (80.6)	3.2 (70.4)	5.2 (55.2)	3.6	3.61	3.87	0.7 (80.56)	1.07 (70.36)	1.73 (55.30)	4.859*
Torso-back (below shoulder level)	1.1	1.4	3.2	0.18 (83.6)	0.32 (77.1)	0.58 (81.9)	0.36	0.47	1.07	0.06 (83.33)	0.11 (76.60)	0.19 (82.24)	0.753
Legs-above knee	10.8	10.82	11.3	1.86 (82.8)	2.6 (76.0)	4.2 (62.8)	3.6	3.61	3.61	0.62 (82.78)	0.87 (75.90)	1.4 (61.22)	4.608 *
Legs-below knee	2.82	2.8	3.6	0.96 (66.0)	1.3 (53.6)	2.12 (41.1)	0.94	0.93	1.2	0.32 (65.96)	0.43 (53.76)	0.71 (40.83)	1.512

SEM : 0.005568

SED : 0.007874

C.D. : 0.015488

t 5% 336 dof = 1.967

(*) more significant.**significant difference at the 0.05 level

Value in the parenthesis indicate % decrease over control

4.5.3 Absorption and Penetration of Dimethoate

This was the third pesticide under study in field conditions. An understanding of the table exhibited that the absorption and penetration of Dimethoate on the various body parts of

the pesticide sprayer differed significantly. The amount of absorption and penetration increased with increase in the number of exposures. This was observed in patches of both control fabric and treated fabric. It was quite evident from

table 3 that there was an increase of 20% to as high as 77% in both absorption and penetration of pesticide in untreated fabric from the 1st to the 3rd spray. Scalp region of the applicator received the lowest absorption and penetration values in control fabric patches comparatively after the 3rd spray while torso back received highest per cent value of both.

But the positive aspect is that both absorption and penetration of Dimethoate pesticide has reduced several folds in treated fabric. The reduction percentage ranged from as low as 6.9 to the highest of 94.6. Lowest reduction was observed in patch applied on leg below knee region and highest value in patch placed on torso back with treated fabric.

Torso front area had the maximum absorption and penetration value of Dimethoate residue in patches of control fabric which was reduced to 73 per cent in treated fabric. Though there was a gradual increase in the treated fabric after each spray, silicon finish could retard the penetration and absorption of the pesticide by nearly 53 per cent at the end of 3rd spray.

Followed the torso front region is leg above knee area or thigh region that received next height residue of the pesticide. After the 3rd spraying, there was 60 per cent reduction of residue in treated fabric over control. An almost similar amount of residue was observed in these two areas on the body of the applicator both in absorption and penetration of Dimethoate which were statistically significant. All residue values were found to be lower when compared to Monocrotophos pesticide and slightly higher than Phosphamidon.

It was also noticed that penetration and absorption values were significantly lower in fabric treated with water repellent finish over control and reason being the blocking effect of water repellent finish on the treated fabric. This indicates that it performed as a barrier to the pesticide. These results are in line with findings of Rajitha and Vastala 2003 [6].

The reason for abdomen region and area of leg above knees to receive highest percentage of residue is due to the height of chilli plant. It usually grows to a height (20-39 inches) that reaches to the height of stomach of the sprayer. So, when pesticide is sprayed on the crop it is possibly to fall on the garment at these regions. This must also be the reason for arm below elbow receiving higher amounts of pesticide than arm above elbow region.

Front torso (abdomen) area was found to be greatly exposed to all three pesticides during spraying. This area was heavily exposed during spraying operation and so had a greater absorption of Monocrotophos (11.6 ng/cm²) followed by Dimethoate (10.2 ng/cm²) and Phosphamidon (6.2 ng/cm²). Next to abdomen area is area of legs above knee, and arm below elbow region that was exposed Phosphamidon pesticide during the first exposure to spraying. Areas exposed to higher level of pesticide (nearly 4 ng/cm² and above) increased as the number of sprayings took place. By the third spraying, except torso back and area of leg below knee and head region, all other areas received huge amount of pesticide. In case of Monocrotophos and Dimethoate, at the end of third spraying 5 areas of 7 areas were loaded with pesticide.

Table 3: Absorption and penetration of Dimethoate pesticide residue in fabric patches (Residues in ng/cm²)

Position of fabric patch on applicator's body	Absorption						Penetration						Mean of three exposures of fabric patch on the body part
	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	
Head	4.6	4.2	5.8	0.36 (92.17)	0.4(90.5)	1.6 (72.4)	1.53	1.4	1.93	0.12 (92.16)	0.12 (91.43)	0.53(72.54)	1.912
Arm-above elbow	4.8	4.5	6.6	0.68 (85.8)	0.98(78.2)	2.2 (66.7)	1.6	1.5	2.2	0.23 (85.63)	0.33 (78.0)	0.73 (66.82)	2.306
Arm-below elbow	4.58	6.1	7.16	1.12 (75.5)	1.16(81.0)	3.2 (55.3)	1.53	2.04	2.39	0.37 (75.82)	0.37 (81.86)	0.39 (83.68)	3.128
Torso-front (abdomen)	7.1	8.4	10.2	1.9 (73.2)	2.9(65.5)	4.8 (52.9)	2.37	2.8	3.4	0.63 (73.42)	0.97 (65.36)	1.6 (52.94)	4.859*
Torso-back (below shoulder level)	0.82	2.8	3.6	0.09 (89.0)	0.15(94.6)	0.47 (86.9)	0.27	0.93	1.2	0.03 (88.89)	0.05 (94.62)	0.16 (86.67)	0.753
Legs-above knee	7.1	8.4	10	1.2 (83.1)	1.96(76.7)	3.9 (61.0)	2.37	2.8	3.33	0.4 (83.12)	0.65 (76.79)	1.3 (60.96)	4.608 *
Legs-below knee	1.2	2.2	2.8	0.86 (28.3)	1.16(47.3)	2.6(7.7)	0.4	0.73	0.93	0.29 (27.50)	0.39 (46.58)	0.87 (6.90)	1.512

SEM : 0.063892

SED : 0.090357

C.D : 0.177732

t 5% 336 dof = 1.967

(*) more significant.

**significant difference at the 0.05 level

Value in the parenthesis indicate % decrease over control

Conclusions

This study was indicated that the treated fabrics had restricted the pesticides residues absorbency in all exposed samples at various body parts over untreated fabric (control) against spraying. The treated fabric reduced the pesticide residues absorbency. Hence, it can be suggested for constructing protective clothing for pesticide applicators in the field to minimize the health problems of applicator due to exposure of pesticides.

References

- Cao L, Chen B, Zheng L, Wang D, Liu F, Huang Q. Assessment of Potential Dermal and Inhalation Exposure of Workers to the Insecticide Imidacloprid using Whole-Body Dosimetry in China. *Journal of Environmental Sciences* 2014;27:139-146.
- Garrigou A, Baldi I, Dubuc P. *Pistes* 2008;10:25-32.
- Karmakar SR. Chemical Technology in the pre-treatment Processes of textiles. *Textile Science and Technology* 1999;12(1):497.
- Nesheim NO, Fishel MF, Mossler M. IFAS Extension Service, University of Florida 2017.
- Rajee PS, Sapna T. Telangana, mirapa sagun upenchukuntunna rastram. *Spice magazine* 2018;3(2):28-30.
- Rajitha I, Vatsala R. Effectiveness of protective clothing for agricultural workers. *Research Gate* 2003.
- Soutar A, Semple S, Robertson A. Use of Patches and Whole Body Sampling for the Assessment of Dermal Exposure. *The Annals of occupational hygiene* 2000;44(7):511-518.