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Variability in Sorption of Diazinon through Microporous Fabrics

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Variation in barrier performance properties of fabrics could considerably effect the protection provided by diffe.ent fabrics. Study conducted by Wardsworth et al (1988) showed significant variation in the barrier properties of non-woven fabrics. While conducting research on water-repellent microporous fabrics, the authors observed considerable variation in the sorption of pesticide by fabric samples taken from different locations in the warp and filling directions. As uniformity is critical for protective clothing, this research was conducted to study the variability in sorption of pesticide by four water-repellent microporous fabrics.

MATERIALS AND METHODS

Ten yards each of nylon, polyester, and acrylic fabrics were purchased from Testfabrics Inc. The fabrics were laminated to polytetrafluoroethylene membrane and treated with a water-repellent finish by W.L. Gore Company. In addition to the above fabrics, a commerically used (for application other than protective clothing) three layer Gore Tex fabric with polyester taffeta outer layer and nylon tricot inner layer was used for the study. The above fabric had a water-repellent finish. Fabric characteristics are given in Table 1.

An emulsifiable concentrate (47.5% a.i.) of diazinon [O,O-diethy-O-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate] was used for the study. The label concentration of active ingredient was checked and verified by gas chromatography.

Approximately 1.5 meter long fabric was cut at least 1

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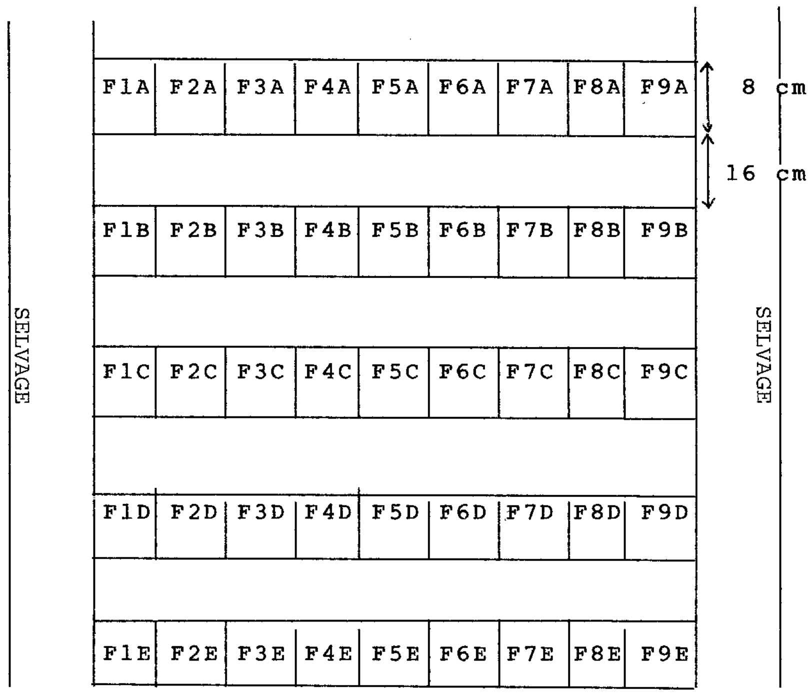

Figure 1: Sampling and coding diagram.

Table 1. Physical characteristics of fabrics used for the study.

Fabric Code	Fabric Weight gm/m^2	Outer fabric characteristics		
		Fiber Content	Weave	Count yarns/cm
Polyester	178.0	Polyester	Plain	22 x 22
Nylon	226.8	Nylon	Plain	17 x 13
Acrylic	214.5	Acrylic	Plain	16 x 13
Commercial Polyester	251.0	Polyester	Plain	32 x 19

meter away from the top or bottom of the 10 yard fabric piece. Cutting and coding diagram used for the study is given in Fig. 1. The left and right selvages were color coded for all four fabrics. As seen from the diagram, 10 cm strips close to the selvages were discarded. The cutting diagram was drawn on the back of the fabrics and 45 samples (8 cm x 8 cm) were coded and cut. The remaining fabric for each sample was labeled and stored.

To simulate an accidental spill in actual use, an emulsifiable concentrate was used. Pipette drop method was used to apply 0.2 mL of pesticide using a fixed volume micropipetter. Excess pesticide was rolled off from the surface of the fabric into a beaker after 10 minutes. Visual observations were made regarding the sorption of pesticide by the fabric samples. Contaminated samples were allowed to air dry overnight under a fume hood. Samples were then placed in 250 mL screw-top erlenmyer flasks and samples extracted in 50 mL acetone for 45 min at 200 rpm. The extraction process was repeated twice for each sample. Extracts were stored in the refrigerator for analysis.

A Hewlett-Packard 5890A gas chromatograph equipped with an N/P thermionic detector, a 7673A automatic sampler, and a series 9000, Model 300 data system was used for the analysis of all extracts. The GC was fitted with a J&W DB-608 large-bore capillary column (0.53 mm I.D.x 30m) maintained at 190^{o}C. The injection port temperature was set to 210^{o}C. The detector was maintained at 250^{o}C for all runs. Helium carrier gas was used at a flow rate of 20 mL min at a head pressure of 210 kPa. Flowrates for the detector gases were set according to the manufacturers recommendations - 3.5 mL min (H_2) and 120 mL min (air). The detector bead-heating current was adjusted to obtain a baseline signal of 20. Under these conditions, the retention time was 3.2 minutes.

For each determination, a 1 mL aliquot of the acetone extract was transferred to a 2 mL crimp-sealed auto-injector vial with the injector set for 2 uL. Quantitation was normally obtained by software comparison of sample peak areas with the area of an external standard (99.8% pure, EPA, RTP; 10 ng/uL in acetone) contained in a calibration table which was updated prior to each series of sample runs. It was discovered early in the project that the detector response became increasingly nonlinear at concentrations above about 100 ng/uL, so manual data reduction had to be used for the higher concentrations by employing a calibration curve plotted from serial dilutions of both standards. Measured pesticide concentrations in ng/uL were first converted to total mg recovered and then to percent of active ingredient and liquid density in each emulsifiable concentrate.

RESULTS AND DISCUSSION

In most samples, when pesticide was applied to the water-repellent fabrics, the solution formed a bead on the surface of the fabric. In Nylon A series, the

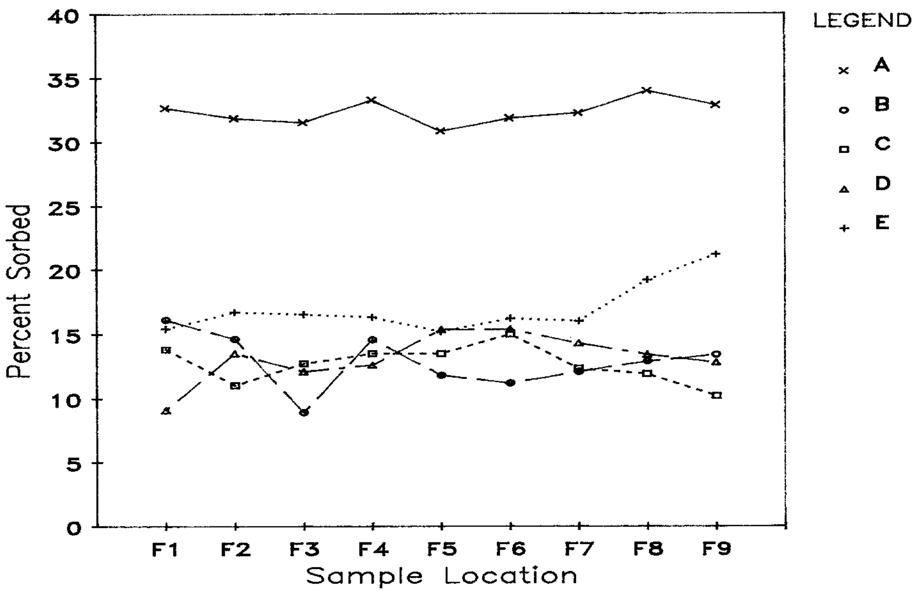

Figure 2: Effect of sample location on percent diazinon sorbed by nylon fabric.

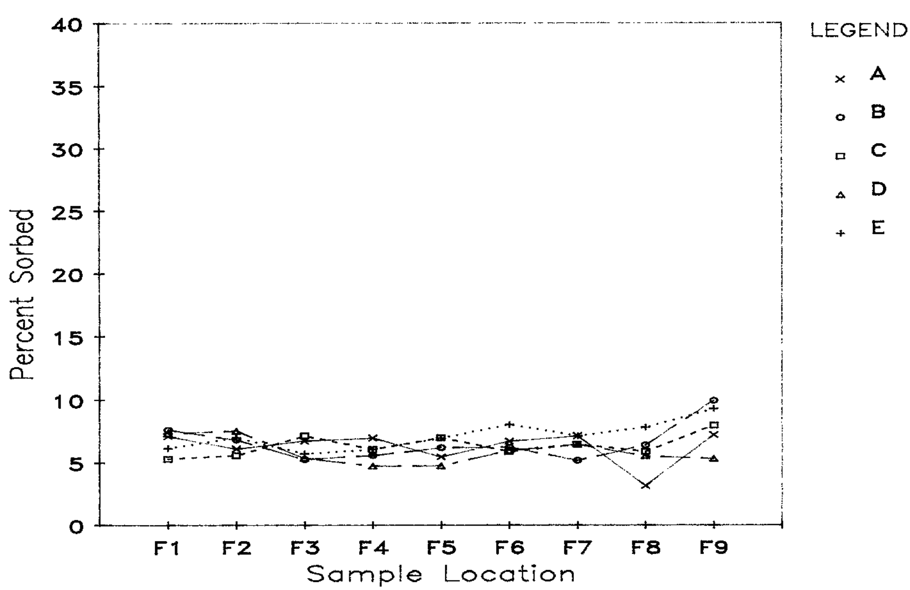

Figure 3: Effect of sample location on percent diazinon sorbed by polyester fabric.

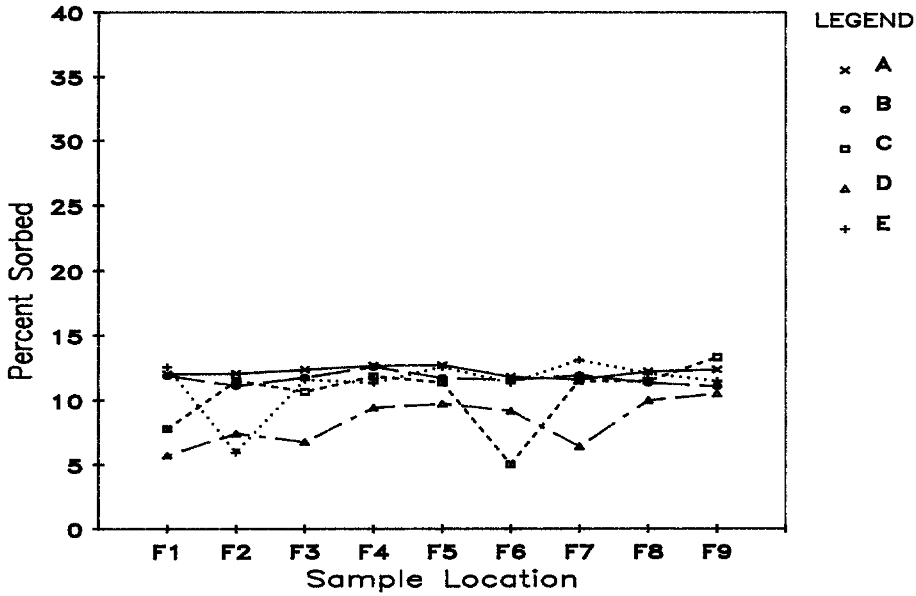

Figure 4: Effect of sample location on percent diazinon sorbed by commercial polyester fabric.

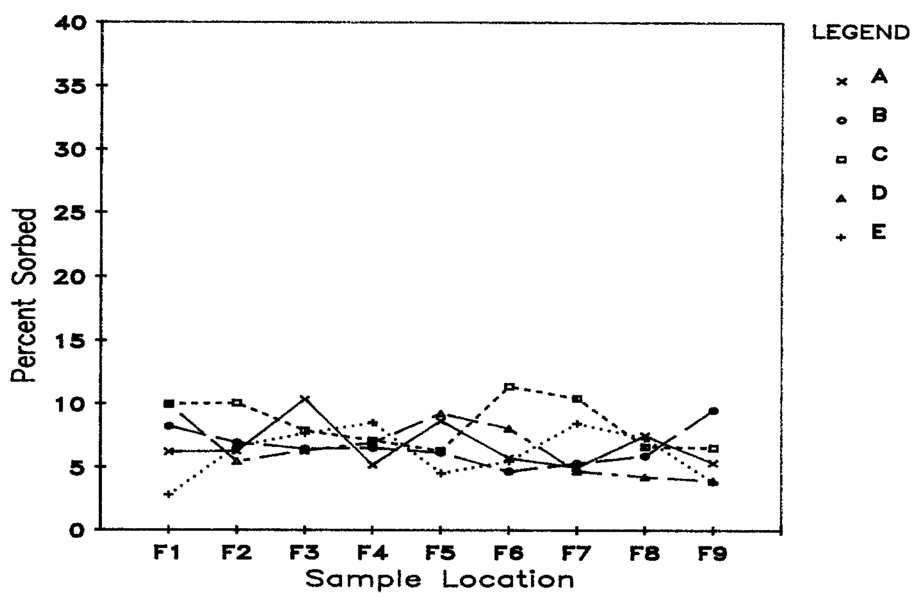

Figure 5: Effect of sample location on percent diazinon sorbed by acrylic fabric.

pesticide was sorbed by the fabric. In Nylon E series, pesticide had started spreading in some samples. Gas chromatograph analysis of the samples (Fig. 2) supports the observations. There was no definite pattern of diazinon sorbed by acrylic, polyester and commercial fabric. The values of percent pesticide sorbed for acrylic ranged from 3.85% to 11.37%. The values for polyester ranged from 3.16% to 9.95%. The lowest percent sorption by commercial fabric was 5.93 and the highest value was 13.33. From observations made while applying the pesticide, it seems that the uniformity of the water-repellent finish is largely responsible for the amount of pesticide sorbed. As the sorption pattern of the Nylon A series seemed very different, the researcher applied water and pesticide to samples from the 10 cm strip adjacent to Nylon F1A and F9A samples. Both water and the pesticide were sorbed by the fabric sample and the sorption pattern was very similar to that of the Nylon A series.

Table 2. Analysis of variance of percent pesticide sorbed by four fabrics at different sample locations.

Source	DF	F Value	Prob < F
Fabric	3	399.46[a]	0.0001
Rep	4	64.42[a]	0.0001
Weft	8	0.32	0.9563
Fabric * Rep	12	53.24[a]	0.0001
Fabric * Weft	24	0.90	0.6052
Weft * Rep	32	0.84	0.7083

[a]Indicates significance at 0.01 level

Analysis of variance results (Table 2) indicate that there was no significant difference due to sample location along the width of the fabric. Also, there was no significant difference due to the interaction of fabric and location along the length, as well as interaction along the length and width of the fabrics. Analysis showed a significant difference due to fabric, location along the length and the interaction between the fabric and location along the length of the fabric.

Student-Newman-Keuls post hoc test, used to identify the differences (Table 3), indicated that for Nylon fabric, there was no significant difference between mean percent values of D, B, and C sample series. There was no significant differences between the mean values of Acrylic and Polyester fabrics.

Results of the study clearly indicate the importance of uniformity in the application of water-repellent finishes, if the fabric is to be used for protective clothing. Improper application can increase the sorption of pesticide by 2.5 fold. Quality control during application of water-repellent finish is very important to ensure worker protection in the field. Based on the results, it is suggested that at least five replications (instead of three) be used by researchers using similar fabrics. Also, importance of standard deviation and the highest sorption reading is emphasized.

Table 3. Student-Newman-Keuls test between sample location of four different fabrics.

Nylon					
Sample Location	A	E	D	B	C
Mean Percent	32.39	16.97	13.18	12.84	12.66
Commerical Polyester					
Sample Location	A	B	E	C	D
Mean Percent	12.23	11.65	11.35	10.51	8.35
Acrylic					
Sample Location	C	A	B	D	E
Mean Percent	8.48	6.71	6.63	6.54	6.15
Polyester					
Sample Location	E	B	C	A	D
Mean Percent	7.12	6.57	6.37	6.31	5.88

NOTE: There is no significant difference between mean values underlined by the same line.

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