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CWL TECHNICAL MEMORANDUM 33-26

INTERIM REPORT

CWL TRAVERSAL PROJECTILE PHASE B - PICK-UP (Effects of Ground Mois

by

Norman Reich

6 June 1960

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Directorate of Development
U. S. Army Chemical Warfare Laboratories
Army Chemical Center, Maryland

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CWL Technical Memorandum 33-26
CWL Traversal Program
Phase B - Pick-Up
(Effects of Ground Moisture)

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ABSTRACT

(U) OBJECT.

The object of this test was to estimate and compare the pick- of VX on traversal of (1) normal or relatively dry contaminated t (2) contaminated rain-soaked terrain, and (3) terrain rain-soaked ately after the dissemination of agent.

(C) RESULTS.

In a series of field trials, the cloth-covered roller was em to determine the transferability of VX from contaminated terrain penetration of agent through cloth. The total pick-up of VX was from terrain which was rain-soaked prior to contamination, and lo from terrain on which heavy rain fell after contamination and bef traversal. The pick-up from normal contaminated terrain was abou that from contaminated rain-soaked terrain. The wetness of terra greatly influenced the penetration of agent. During the traversa terrain, roughly 35% of the agent picked up by the roller was tra by the moisture through the outer layer of cloth and was found on bottom or inner layer, as compared to a penetration of less than the traversal of the relatively dry terrain.

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INTERIM REPORT
CWL TRAVERSAL PROGRAM
PHASE B - PICK-UP
(Effects of Ground Moisture)

I. (U) OBJECT.

The object of this test was to estimate and compare the pick-up of VX on traversal of (1) normal or relatively dry contaminated terrain, (2) contaminated rain-soaked terrain, and (3) terrain rain-soaked immediately after the dissemination of agent.

II. (U) AUTHORITY.

This study was authorized in the fiscal year 1960 Research and Development Program, project no. 4C04-15-032, Toxic CW Munitions, and specifically under subproject no. 4C04-15-032-14, Techniques for Field Evaluation of CW Munitions.

III. (C) INTRODUCTORY REMARKS.

Earlier field trials investigated the transferability of agent from relatively dry vegetated terrain on which VX was disseminated. The results obtained were considered specific for the terrain condition existing during the trials, particularly since laboratory tests indicated that terrain moisture had a pronounced effect on pick-up. To corroborate the laboratory results and investigate further the affects of terrain moisture on pick-up, the field trials described in this memorandum were conducted on the same test site as were the earlier field trials. In these trials, the cloth-covered roller technique was employed. The ability of this technique to reflect, with fair accuracy, the pick-up on troops crawling across contaminated terrain, as when advancing under fire, was proven and discussed in CWL Technical Memorandum 33-19; subject: Interim Report, CWL Traversal Program, Phase B - "Pick-Up"; dated 10 February 1959.

It should be recognized that the results presented in this document were derived from a rather cursory investigation, and as such are considered interim in nature. Therefore, this information is issued for temporary and limited use only, and may be superseded when additional trials are performed.

IV. (C) EXPERIMENTAL.

A. Procedure.

The test was performed in accordance with Test Directive for Field Test 2102, subject: Field Test to Determine Effects of Ground Moisture on Agent Pick-Up (U), dated 5 February 1959. As prescribed in the test directive, the terrain conditions and the procedure employed were as follows:

1. Contaminated Dry Terrain.

The test site consisting of terrain with a moderately dense covering of short grass was divided into six 2-m by 25-m strips. Each of these strips was subdivided into two one-meter paths. Three strips were contaminated with large droplets of VX generated by the multi-jet disperser equipped with dropping needles. The remaining three strips were similarly contaminated with VX in shattered or small droplets from the same disseminating device equipped with air-operated spray nozzles. The degree and uniformity of contamination were determined by the use of sampling pans containing isopropanol. These pans were placed randomly across the width of the test strip, two pans for each 5 m of strip length. Immediately following the dissemination of VX, the solvent in the pans were stirred and poured into individual sampling bottles and forwarded to the laboratory for analysis on the same day. The particle size of the large droplets was determined by obtaining the mass of a number of captured droplets, and the particle size distribution of the smaller droplets was determined by measuring the stains produced by the droplets on M6 detector paper.

One-half hour after the start of contamination, one path of each strip was traversed at a fixed rate by a 13-in. diameter roller covered with two layers of laundered, bleached cotton sateen cloth. The second path of each strip was similarly traversed 3 hr later. Immediately after each traversal, each layer of cloth was removed from the roller, stuffed into individual wide-mouthed bottles containing isopropanol, and delivered to the laboratory for analysis on the day of sampling. The quantity of VX on each cloth sample was determined by the DB-3 technique.

2. Contaminated Rain-Soaked Terrain.

The trials described in par 1, above, were repeated on wet terrain as would exist after a heavy rainfall. These trials were performed twice, once during early spring when the terrain was normally wet and once during late spring when the terrain had to be wetted by simulated rainfall prior to the application of agent. The latter trials were performed within days of the trials described in par 1 and 3. This was done to eliminate the seasonal differences in grass density as a variable when comparing pick-up. In the earlier trials, the terrain was visibly saturated with water, and the rainfall necessary to produce this wetness was not known. In the later trials, the amount and uniformity of simulated rainfall was determined from the contents of ten containers placed randomly on each test strip before spraying the terrain with water.

3. Rain-Soaked Contaminated Terrain.

The trials described in par 1, above, were repeated in a modified form. The strips were prepared and contaminated as described; however, immediately after the dissemination of agent and the removal of sampling pans, the ground was subjected to a heavy simulated rainfall. The traversal schedule was modified so that the first path was traversed 1 hr after the agent was disseminated, and the second path 2 hr later.

B. Results.

The data derived from this series of trials are presented in tables 1 and 2.

The average particle size of agent disseminated as large droplets was about 2.5 mm, and the small particles had a mass median diameter averaging approximately 0.6 mm. Test strips were contaminated to densities varying from 1.6 to 7.0 g/sq m, and as indicated in the standard deviations in the 10 determinations per strip (see table 1), the uniformity of contamination was less than desired. Strips A through F were relatively dry when contaminated. Strips G through L, which were wetted after contamination, and strips M through R, which were wetted before contamination, were similarly subjected to a 20-min simulated rainfall. In both cases, the quantity of water applied to these strips was equivalent to that produced by a 3/4-in. rainfall.

Strips A through F and M through R were traversed by the cloth-covered roller 1/2 hr and 3-1/2 hr after contamination. Strips G through L were wetted 1/2 hr after contamination, and traversed 1 hr and 3 hr after contamination. Agent disseminated on wet terrain proved to be most efficiently transferred to the roller. On the first traversal, the total pick-up from strips M through R was roughly 30% higher than the pick-up from strips A through F, and 10 times that from strips G through L. On the second traversal, the efficiency of transferability remained in the same order; however, there was a sharp decline in the quantity of agent transferred. Ground moisture aided considerably in transporting agent through the cloth. As determined from the quantity of agent present on the inner or bottom cloth layers, the greatest penetration resulted when contaminated wet terrain was traversed, and the least when normal or dry terrain was traversed.

Trials on strips S through X paralleled those performed on strips M through R. Strips S through X, however, were traversed 1/2 hr and 4-1/2 hr after contamination. Also, these trials were performed earlier in the year when the vegetation was somewhat less dense. In general, the same effects of soil moisture on pick-up were observed. However, as a result of differences in terrain characteristics as well as in soil moisture, the pick-up and penetration from strips S through X were considerably less than from strips M through R.

In these trials, it frequently appeared that agent disseminated in smaller particles was more transferable and had greater penetrability than larger particles. Because of the variance in individual determinations, additional trials are required to establish the significance of the apparent effects of particle size on pick-up and penetration.

Date of trial	Terrain condition	Test strip	Contamination density g/sq m ± σ	Approx particle size mm MMD	Simulated rainfall in. ± σ	Ro. r m/
19 May 59	Normal	A	5.81 ± 2.26	2.5	0	8
		B	5.43 ± 1.32	2.5	0	9
		C	5.30 ± 1.07	2.5	0	9
20 May 59	Normal	D	4.23 ± 2.42	0.6	0	13
		E	5.61 ± 2.03	0.6	0	12
		F	6.03 ± 2.09	0.6	0	13
21 May 59	Wet after contamination	G	5.13 ± 1.54	2.5	0.76 ± 0.46	10
		H	4.60 ± 1.14	2.5	0.83 ± 0.44	9
		I	3.89 ± 0.87	2.5	0.53 ± 0.22	10
25 May 59	Wet after contamination	J	6.32 ± 2.94	0.6	0.76 ± 0.33	10
		K	6.50 ± 2.39	0.6	1.10 ± 0.26	10
		L	5.87 ± 2.83	0.6	0.50 ± 0.13	10
26 May 59	Wet before contamination	M	2.17 ± 0.98	2.5	X	9
		N	2.28 ± 1.10	2.5	X	10
		O	3.46 ± 0.66	2.5	X	10
27 May 59	Wet before contamination	P	7.00 ± 2.55	0.6	X	10
		Q	6.31 ± 3.19	0.6	X	10
		R	5.32 ± 2.71	0.6	X	10
2 Mar 59	Wet before contamination	S	2.27 ± 0.73	2.5	XX	9
		T	1.59 ± 0.40	2.5	XX	11
		U	1.67 ± 0.71	2.5	XX	9
4 Mar 59	Wet before contamination	V	3.43 ± 0.57	0.6	XX	10
		W	1.59 ± 1.20	0.6	XX	8
		X	2.66 ± 0.75	0.6	XX	11

* Strips A thru F and M thru X were traversed 30 min after contamination; Strips G th

** Interval between first and second traversal was 2hr for Strips G thru L,

X Rainfall not determined. Strips M thru R were wetted identically to Strip

XX Rainfall not determined. Terrain was naturally saturated with water.

1

Table 1

Effects of Moisture on the Pick-Up of VX From Terrain

Approx particle size	Simulated rainfall	First Traversal*			Second Traversal**			
		Roller rate	Pick-Up on cloth		Roller rate	Pick-Up on cloth		
			Top	Bottom		Top	Bottom	
mm MMD	in. ± σ	m/min	mg	mg	m/min	mg	mg	
2.5	0	8.7	392	3.6	11.0	94	0	Av Air T
2.5	0	9.9	511	1.1	9.5	86	0	Strip C
2.5	0	9.4	374	2.8	10.2	58	0	
0.6	0	13.0	644	0.9	13.7	184	0	
0.6	0	12.5	956	0.7	13.4	109	0	Av Air T
0.6	0	13.7	1,010	1.9	13.7	199	0.5	
2.5	0.76 ± 0.46	10.3	53	43	10.2	25.4	7.3	Av Air T
2.5	0.83 ± 0.44	9.7	33	30	9.7	12.0	1.3	Slight q
2.5	0.53 ± 0.22	10.6	37	29	10.5	12.2	1.1	traverse
0.6	0.76 ± 0.33	10.9	75	62	10.5	59	33	Av Air T
0.6	1.10 ± 0.26	10.0	47	37	10.1	67	43	Some sta
0.6	0.50 ± 0.13	10.8	69	33	10.3	14.3	0.4	Strip K
2.5	X	9.9	183	59	9.7	53	17.4	Av Air T
2.5	X	10.2	183	100	9.9	40	3.0	Standing
2.5	X	10.1	375	51	9.4	60	2.3	
0.6	X	10.9	1,050	402	10.5	271	100	Av Air T
0.6	X	10.5	738	522	10.4	126	166	Standing
0.6	X	10.8	854	540	10.6	270	49	
2.5	XX	9.7	168	10.4	10.9	55	9.0	Av Air T
2.5	XX	11.6	122	11.6	11.3	36	2.0	Strip U
2.5	XX	9.5	308	158	10.9	59	23.0	
0.6	XX	10.1	158	13	10.7	130	10.0	Av Air T
0.6	XX	8.6	52	14	10.1	27	3.0	Strip W
0.6	XX	11.0	164	14	11.0	46	4.0	

n s ter contamination; Strips G thru L were wetted 30 min after contamination and traversed 30 min afterwar
hr for Strips G thru L, 3 hr for Strips A thru F and M thru R, and 4 hr for Strips S thru X.
ted identically to Strips G thru L.
aturated with water.

m Terrain

aversal** Pick-Up on cloth		Remarks
Top	Bottom	
mg	mg	
94	0	Av Air Temp 71°F; Ground Temp 82°F; Relative Humidity 86%. Agent Purity 100%
86	0	Strip C appeared rougher than A or B.
58	0	
84	0	
09	0	Av Air Temp 75°F; Ground Temp 88°F; Relative Humidity 79%. Agent Purity 99%.
99	0.5	
25.4	7.3	Av Air Temp 75°F; Ground Temp 83°F; Relative Humidity 81%. Agent Purity 86%
12.0	1.3	Slight quantities of standing water were present on strips during the first
12.2	1.1	traversal.
59	33	Av Air Temp 66°F; Ground Temp 82°F; Relative Humidity 50%. Agent Purity 96%.
67	43	Some standing water present on all strips.
14.3	0.4	Strip K was more uneven than Strips J and L.
53	17.4	Av Air Temp 68°F; Ground Temp 77°F; Relative Humidity 63%. Agent Purity 82%.
40	3.0	Standing water appeared only in Strip O.
60	2.3	
71	100	Av Air Temp 74°F; Ground Temp 82°F; Relative Humidity 67%. Agent Purity 94%.
26	166	Standing water was present on Strip Q during first traversal.
70	49	
55	9.0	Av Air Temp 44°F; Ground Temp 47°F; Relative Humidity 67%. Agent Purity 82%.
36	2.0	Strip U appeared rougher and wetter than Strips S or T.
59	23.0	
30	10.0	Av Air Temp 50°F; Ground Temp 54°F; Relative Humidity 38%. Agent Purity 61%.
27	3.0	Strip W with standing water appeared rougher and wetter than Strips V and X.
46	4.0	

nd traversed 30 min afterwards.
rips S thru X.

Table 2
Comparative Values of Total Pick-Up and Penetration

Terrain condition	Particle size of VX	Test strip	First Traversal		Second Traversal	
			Total	Bottom Layer	Total	Bottom Layer
			%	%	%	%
Normal	Large	A	0.27	0.0024	0.064	0
		B	0.38	0.0008	0.064	0
		C	0.28	0.0020	0.044	0
	Small	D	0.61	0.0008	0.18	0
		E	0.68	0.0004	0.076	0
		F	0.67	0.0012	0.13	0.0004
Rain after contamination	Large	G	0.076	0.034	0.026	0.0056
		H	0.056	0.026	0.011	0.0012
		I	0.068	0.030	0.013	0.0012
	Small	J	0.088	0.039	0.060	0.021
		K	0.052	0.023	0.072	0.026
		L	0.068	0.022	0.010	0.0004
Rain before contamination	Large	M	0.45	0.11	0.128	0.032
		N	0.50	0.18	0.076	0.0052
		O	0.50	0.06	0.072	0.0028
	Small	P	0.83	0.23	0.21	0.056
		Q	0.80	0.33	0.18	0.10
		R	1.05	0.41	0.24	0.036
Wet before contamination	Large	S	0.31	0.018	0.11	0.016
		T	0.34	0.029	0.096	0.0052
		U	1.12	0.38	0.20	0.056
	Small	V	0.20	0.015	0.16	0.012
		W	0.17	0.035	0.076	0.008
		X	0.27	0.021	0.076	0.006

*Pick-up per meter traversed by the cloth-covered roller, expressed as the percent of the initial contamination density found on both layers (total) and on bottom layer of cloth. Cloth dimensions: 24 x 42 in.

DEPARTMENT OF THE ARMY
US ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND
EDGEWOOD CHEMICAL BIOLOGICAL CENTER
5183 BLACKHAWK ROAD
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Security Manager

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