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Oviposition Response of the Army Cutworm, *Chorizagrotis auxiliaris*, to Different Media[1]

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Abstract

Moths of the army cutworm, *Chorizagrotis auxiliaris* (Grote), (Lepidoptera: Noctuidae) responded ovipositionally to differences in soil color, texture, and depth. Number of eggs laid increased with amount of light reflected. A combination of loose surface over a solid substrate was required. A light-colored sand fulfilled all requirements and was preferred over soil. Soil was acceptable when a loose surface of correct depth was provided. Solid surfaces were refused.

The army cutworm, *Chorizagrotis auxiliaris* (Grote), (Lepidoptera: Noctuidae) is an important pest of wheat, barley, alfalfa, and other crops in the Great Plains. Jacobson & Blakeley (1959) discuss factors favoring general increases in army cutworm populations. Within an outbreak area there also are often large differences in populations between adjacent fields. Pruess (1961) found that winter barley usually had higher populations than adjacent wheat fields. These differences must be caused either by differences in larval establishment or by number of eggs laid. The latter is considered in this study.

Little information is available on the oviposition habits of this cutworm moth. Johnson (1905) was undoubtedly in error in reporting eggs laid on foliage. Cooley (1916) reported that eggs may be laid on the underside of clods, buried below the surface in loose soil, or laid on the surface in dry, hard fields. Strickland (1916) concluded that eggs were laid in, rather than on, soil. Blakeley et al. (1958) found a loose soil suitable for oviposition.

To determine the conditions suitable and favored for oviposition, a variety of soils and other media were compared for attractiveness as oviposition sites.

Methods

Moths of the army cutworm were collected in a black light trap during September and October, 1958, and refrigerated at 35°F. until needed. Most moths were used within a week after collection, but a few were held as long as a month without serious mortality. Those stored for prolonged periods laid fewer eggs.

Tests were conducted in a laboratory having windows along the entire north wall. Cubical cages, either 2 or 3 feet on a side, were used to contain the test media and moths. Except for the 1-inch framework and a plywood bottom, these cages were of screencloth.

Soils or other test media were placed in 8-cm lids of circular cardboard cartons. These dishes were filled with test media to a depth of approximately one-half inch except in tests comparing specified depths. When shallower depths were used, a layer of plaster of Paris or hard soil was used in the bottom of the dish to equalize surface levels.

The media used were a coarse sand consisting of particles passing an 18-mesh screen but retained by a 40-mesh screen; coarse perlite[2] of the above size; and fine perlite, sand, and soil all finer than 60-mesh. The fine sand was actually somewhat coarser than the soil and much lighter in color as shown in figure 1, which depicts several media used. The soil was Holdrege very fine sandy loam taken from the top 4 inches of a cultivated field.

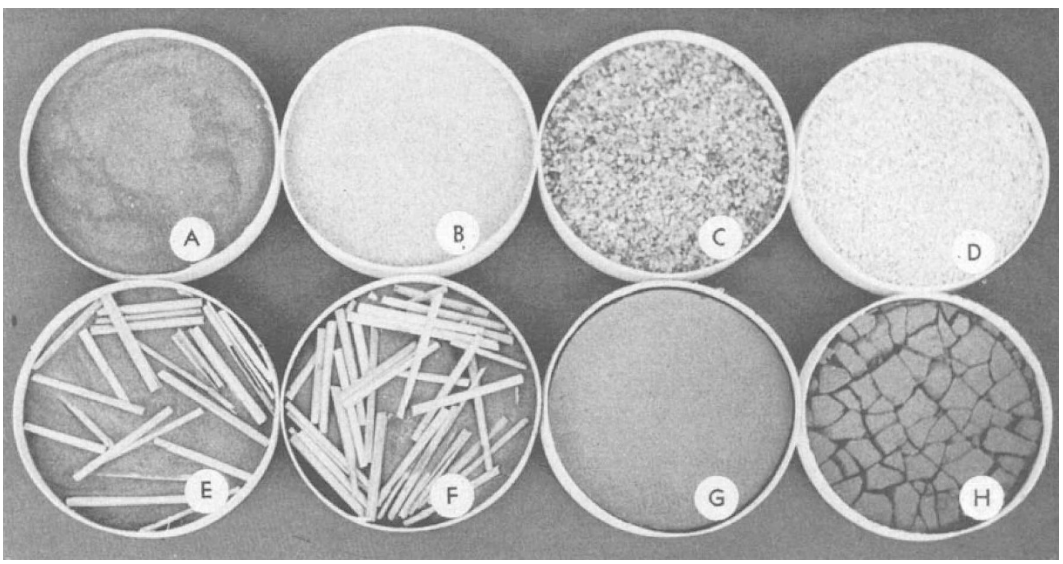

Figure 1. Oviposition dishes containing several test media. A, soil; B, fine sand; C, coarse sand; D, perlite; E, soil + 20 straws; F, soil + 40 straws; G, solid surface; H, cracked surface.

Wheat straws were used to simulate a mulch in several tests. Straws were cleaned of leaf sheaths and cut in pieces averaging 1¼ inches in length. Colored straws used in several tests were dyed by boiling in Rit.[3] Sand was colored with a coal tar dye food coloring. The dye was dissolved in the minimum amount of hot water needed to wet the media, blended thoroughly, and oven dried. This method resulted in very uniform and intense colors.

The number of moths used per test varied with the number of dishes of media used in the cage but averaged four moths per dish. A honey-water mixture was provided as food in all tests. Moths were permitted to oviposit over a 2- to 5-day period after which media were removed and eggs counted. Most tests were repeated. Dead moths were removed and counted and additional moths added before repeating a test. At the conclusion of each test, any living moths were killed and all were sexed. Male:female sex ratio varied from 2.6:1.0 to 0.6:1.0 and averaged 1.3:1.0 over all tests.

Eggs from each dish were spread evenly over a crosshatched paper and counted under a dissecting microscope at 10×. A grid in the eyepiece further facilitated counting. If there were more than 400 eggs in a dish, the total was estimated by counting only a few randomly chosen squares. Eggs were easily retained by a 60-mesh screen but either passed through or were held in the openings of a 40-mesh screen. In tests in which particles coarser than 40-mesh were used, containers were held until the eggs hatched and first instar larvae were counted. This proved necessary as eggs adhered to the large particles and could not be sifted loose. Viability of eggs was close to 100% in all tests.

Since variance of treatments within a test increased proportionately to the means, all data were transformed by log (x) for analysis. In these tests certain dishes, if containing an acceptable medium, seemed to receive an undue proportion of the total eggs. For example, in Test 8 (table 3) the soil with brown straw received 8,653 eggs, but 4,140 of these were deposited in only one of the eight replicates. The logarithmic transformation minimized the weight given these large counts due solely to position within a cage while giving more weight to those treatments consistently receiving moderate numbers of eggs regardless of position. In several tests new randomizations were made before repeating the test. Both actual egg counts and transformed means are given in the tables of results. Duncan's Multiple Range Test was used to determine significance among the transformed means. Any two means not connected by the same vertical line are significantly different at the 5% level.

Results

Soil Texture and Depth

Fine and coarse sand and soil were mixed in various proportions as listed in Test I, table 1. Significantly fewer eggs were laid in soil than any other media in this test. In Test 2, fine sand was also preferred over soil which in turn received significantly more eggs than fine perlite. The coarse perlite and sand appeared unacceptable in the presence of other media. The fine perlite was too light in density to support a moth and those observed in this media were usually struggling to crawl through it.

Table 1. Oviposition response of the army cutworm to differences in soil texture

		Number of Eggs	
Test	Comparison	Total	Transformed Mean
1	Fine sand	17,955	2.740
	3 fine sand:1 coarse sand	14,045	2.722
	3 fine sand:1 soil	12,430	2.673
	2 fine sand:2 soil	11,595	2.672
	1 fine sand:3 soil	10,320	2.648
	1 fine sand:2 soil:1 coarse sand	11,910	2.637
	3 soil:1 coarse sand	9,505	2.561
	2 fine sand:1 soil:1 coarse sand	9,055	2.330
	Soil	3,612	2.027
2	Fine sand	33,411	3.051
	Soil	6,433	2.437
	Fine perlite	3,247	1.756
	Coarse sand	30	0.234
	Coarse perlite	1	0.000

The preference for fine sand over soil appeared due to a requirement for a solid object on which to place eggs. Nearly all eggs laid in the soil were attached to the sides of containers at a uniform depth of 1/4 to 3/8 inch below the soil surface (fig. 2). In media containing some sand, eggs appeared randomly distributed throughout the dishes. Since coarse sand or perlite received few eggs, it appeared that a combination of loose surface over a solid substrate might be essential. Presumably fine sand provided enough solidity to form a solid oviposition substrate but maintained a sufficiently loose surface which the moth could probe with its abdomen.

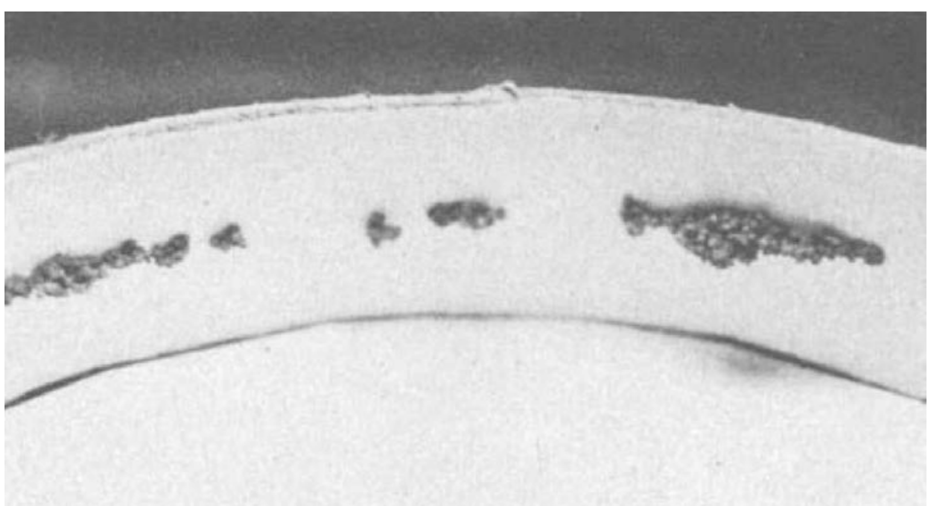

Figure 2. Dish with soil removed showing eggs attached at uniform depth to side of container.

The optimum depth of this loose surface was further investigated and results of these tests are given in table 2. There was no significant difference between number of eggs laid in 1/8 or 3/8 inch of fine sand over a solid substrate in Test 3, but the actual number of eggs laid was considerably higher when the solid substrate was only 1/8 inch below the sand surface. Likewise there was no significant difference between these depths of silt over a solid substrate although the deeper depth of soil received more than twice as many actual eggs. Sand received more eggs than soil.

Table 2. Oviposition response of the army cutworm to different depths of loose surface and types of substrate

		Number of Eggs	
Test	Comparison	Total	Transformed Mean
3	1/8″ sand over solid substrate	12,085	2.702
	3/8″ sand over solid substrate	6,795	2.484
	3/8″ soil over solid substrate	3,430	2.192
	1/8″ soil over solid substrate	1,375	1.841
4	3/8″ soil over cracked substrate	22,100	3.229
	3/8″ soil over solid substrate	18,560	3.134
	Cracked soil surface	50	0.287
	Solid soil surface	15	0.133
5	3/8″ soil over solid substrate	5,245	2.606
	3/8″ soil over cracked substrate	4,150	2.339
	1/16″ soil over cracked substrate	3,960	2.334
	1/16″ soil over solid substrate	2,665	2.122
6	3/8″ soil over solid substrate	1,525	2.190
	Clods mixed with soil	790	1.997
	1/16″ soil over solid substrate	675	1.980
	Soil in surface cracks	1.50	1.347

Although not significant by the tests made, further tests and observations indicated that these probably represented true biological differences. In all tests involving loose surfaces it was possible for moths to work this surface about, invariably toward the edge of the dish, thus creating a variable depth. Observations indicated that under these conditions most of the eggs in sand were near the center of the dish where shallower depths prevailed while in soil eggs were placed nearer the edge at deeper depths.

Solid surfaces without a loose covering were refused in all tests. Results of Test 4 indicate that cracks in an otherwise solid surface were also refused, but that either a solid or cracked substrate beneath a loose surface was acceptable. Cracks in the substrate may influence the depth of loose surface necessary and further confirmed previous observations that a specific depth was needed. Results of Test 5 indicated that a shallower loose surface was acceptable over a cracked substrate. The number of eggs laid did not differ significantly between 3/8 and 1/16 inch loose soil over a cracked substrate. However, there was a difference in placement of these eggs. Figure 3 shows eggs placed in the cracks under 1/16 inch of soil but on the substrate surface when the overlying layer of loose soil was increased to 3/8 inch. Test 6 gave similar results. There was no significant difference between 1/16 and 3/8 inch depths of loose soil over a cracked substrate but the greater depth resulted in more eggs being deposited over a solid substrate.

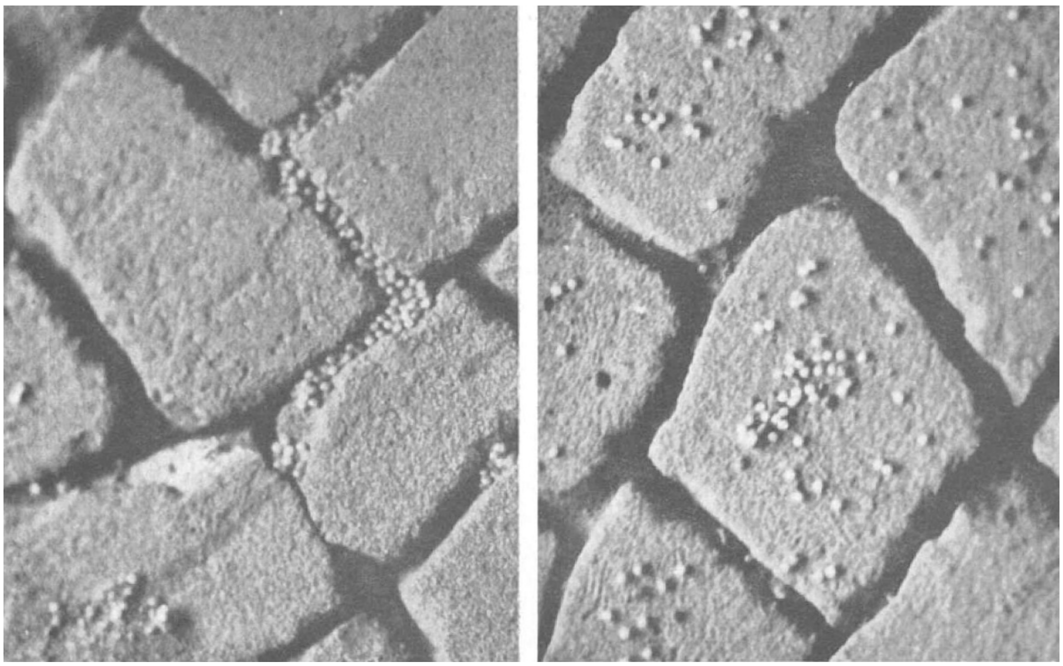

Figure 3. Loose soil removed showing placement of eggs in cracks (left) beneath 1/16″ of soil but on substrate top (right) beneath 3/8″ soil.

Filling only the cracks with loose soil did not result in an attractive media in Test 6, although a few eggs were laid. Small clods mixed with loose soil in this test provided a satisfactory oviposition media. This treatment was similar to conditions normally present in small grain fields during the egg-laying period.

Buried straw furnished a suitable substrate in Test 7 (table 3). The increase in number of eggs laid in dishes containing buried straw was not significantly greater than for soil alone, but the placement of eggs on these straws (fig. 4) rather than around the edge of the dish was convincing evidence that there was a biological difference.

Table 3. Oviposition response of the army cutworm to differences in straw mulch

Test	Comparison	Number of Eggs: Total	Number of Eggs: Transformed Mean
7	Soil + 40 surface straws	8,220	2.574
	Soil + 20 surface straws	7,605	2.535
	Soil + 40 buried straws	6,880	2.352
	Soil + 20 buried straws	4,285	2.055
	Soil alone	3,055	2.040
8	Soil + yellow straw	9,320	3.750
	Soil + undyed straw	7,528	2.750
	Soil alone	5,065	2.438
	Soil + green straw	5,765	2.351
	Soil + brown straw	8,653	2.203
9	Soil + 40 yellow straws	11,145	2.961
	Soil + 20 yellow straws	10,300	2.871
	Soil alone	5,536	2.568
	Soil + 20 green straws	5,112	2.440
	Soil + 40 green straws	3,677	2.349
10	Sand +·40 yellow straws	4,430	2.565
	Sand + 20 yellow straws	7,015	2.560
	Sand alone	6,985	2.533
	Sand + 20 green straws	5,815	2.511
	Sand + 40 green straws	3,215	2.197

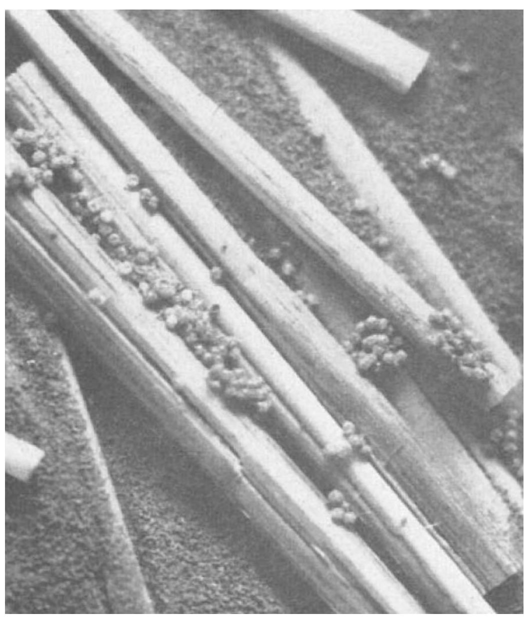

Figure 4. Top 3/8″ soil removed showing placement of eggs on straw buried beneath surface.

Placement of straw on the soil surface in Test 7 did result in a significant increase in the number of eggs deposited. This was somewhat surprising as the increased stability of the surface due to straws would, if anything, be expected to interfere with oviposition. However, the addition of straw added another variable, color, which appeared of importance.

Mulch and Color

As seen in Test 7, the addition of straw on the surface increased the number of eggs laid in soil. Further results are also given in table 3. Test 8 showed undyed or yellow straws increasing the number of eggs laid in soil over the number laid when a brown or green straw mulch was used. Test 9, using two rates—20 and 40 straws per dish—showed this same color response. Soil without straw ranked intermediate in the number of eggs laid in both tests.

The addition of colored straws to the lighter colored sand appeared of less importance. In Test 10 the addition of 40 green straws resulted in the fewest eggs, but other differences were not significant.

In Test 11 (table 4) 20 to 40 green or yellow straws were added to dishes of sand which were wetted and allowed to dry, forming a crusted surface. In this test, bare sand received more eggs than sand to which any color or amount of straw had been added. There was no significant difference between treatments, but a comparison of straw vs. none was significant. In this test, straws stabilized the surface, which made it less easily broken by the moths than bare sand. Results in this test were extremely variable, with eggs being concentrated in the few dishes in which the crusted surface was broken.

Table 4. Oviposition response of the army cutworm to physical and visual differences in sand created by addition of straw mulch

		Number of Eggs	
Test	Comparison	Total	Transformed Mean
2	Crusted sand	14,720	1.875
	Crusted sand + 20 green straws	3,810	1.815
	Crusted sand + 20 yellow straws	4,527	1.794
	Crusted sand + 40 green straws	6,990	1.760
	Crusted sand + 40 yellow straws	2,525	1.731
12	Yellow sand	8,420	2.512
	Yellow sand + yellow straw	6,875	2.394
	Green sand	4,270	2.228
	Green sand + green straw	4,735	2.212

The addition of straws to dry sand or soil, at least up to 40 per dish, did not seem to interfere with oviposition. Test l2 compared green and yellow sand with and without 40 straws of the same color as the sand. In this case, the only difference was between colors, with straws having no apparent effect.

Since light intensity was not controlled in any test, it is impossible to say whether there was any spectral response as Callahan (1957) showed to exist for the corn earworm, *Heliothis zea* (Boddie). It was observed in all tests that those media reflecting the more light received the most eggs. This would make it appear that light intensity was involved. Even in those tests in which there was no color difference between media, it was noted that most eggs were laid in those replicates nearer the window. Egg laying was never begun before 7 p.m. and often not until 9 p.m. in these tests. However, on moonlight nights a visual difference between replicates as well as treatments could be noted, and it seemed possible that moths were more attracted to the lighter surfaces. This might also explain why the light-colored sand received more eggs than soil in all tests even though both media, when of proper depths over a solid substrate, provided suitable oviposition sites.

Discussion

Moths of the army cutworm respond ovipositionally both to visual and physical differences in soils. It appears that any potential oviposition site must be visually attractive in relation to adjacent sites. If other soil properties are similar, the most reflective surface received the most eggs. It must be emphasized that a loose surface and solid substrate were essential regardless of visual attractiveness and that moths confined in cages responded ovipositionally to very small differences in soil texture or depth of loose surface.

Under field conditions, visual attractiveness may be of greatest importance. Soil conditions fulfilling the other physical requirements for egg laying are present in most cultivated fields during the oviposition period. The importance of visual attractiveness could well explain the preference for barley over wheat under otherwise identical cultural practices since, at the time moths are ovipositing, winter barley is considerably lighter in color.

The physiological mechanisms in the moth responsible for this selection are unknown. In addition to the apparent light response, the moth requires a loose surface, which it probes with its abdomen, and a solid object on which the eggs are laid.

Notes

1. Published with approval of the Director as Paper No. 1067 Journal Series, Nebraska Agricultural Experiment Station. This investigation was supported by a research grant from the Nebraska Wheat Commission. Accepted for publication September 27, 1960.
2. Western Mineral Products Company, Omaha, Nebraska.
3. Rit Products Division, Indianapolis, Indiana.

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