

## ARTICLES

COMPARISON OF FAST NEUTRONS AND GAMMA RAYS IN PRODUCING STERILITY IN *CULEX PIPPIENS QUINQUEFASCIATUS* SAY<sup>1</sup>B. J. SMITTLE,<sup>2</sup> G. C. LABRECQUE,<sup>2, 3</sup> R. S. PATTERSON<sup>2, 3</sup>  
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**ABSTRACT.** *Culex pipiens quinquefasciatus* Say pupae were exposed to fast neutrons produced by a Van de Graaff accelerator or gamma rays from a cobalt-60 source. Over 99 percent sterility was produced in males by 2000 rad from neutrons and 7500 R from gamma rays. Oviposition was completely inhibited by 2000 rad

from neutrons and 7500 R from gamma rays. When both sexes were irradiated, 750 rad from neutrons and 5000 R from gamma rays produced about 95% sterility. These data indicate that fast neutrons are 3.75 to 6.67 times as effective as gamma rays in producing sterility in this mosquito.

Murakami (1966), Klassen *et al.* (1969), and Smittle *et al.* (1971) indicated that fast neutrons were more effective than gamma or X-rays in producing sterility in the silkworm, *Bombyx mori* (L.), the boll weevil, *Anthonomus grandis* Boheman, and the house fly, *Musca domestica* L., respectively. Since *Culex pipiens quinquefasciatus* Say (= *fatigans* Wiedemann) is one of the species of mosquitoes most likely to be controlled with a sterile male release program, we exposed pupae to fast neutrons or gamma rays and compared the effectiveness of each in sterilizing this mosquito.

**MATERIALS AND METHODS.** The mosquitoes used were obtained from a laboratory colony maintained for 2 years at Gainesville, Florida. For irradiation, 50 male and 50 female pupae (less than 24 hours after pupation) were placed in a holding chamber and irradiated. This chamber consisted of a frame made of a 5-cm square of Plexiglas® 1.5 mm thick in which a

2.5 cm diameter hole had been drilled. One side of the frame was covered with nylon net; the pupae were placed in the hole in the frame, and moist blotter paper was placed over the pupae. This arrangement held the pupae in a moist environment between the nylon net and blotter paper during irradiation.

The gamma rays were produced by a cobalt-60 source similar to that described by Jefferson (1960); the dose rate ranged from 1815 to 1856 R/min. The neutrons were produced by bombarding a thick beryllium target with deuterons produced by a 4 MeV Van de Graaff accelerator. This <sup>9</sup>Be(d,n)<sup>10</sup>Be reaction produced neutrons with energies from approximately 0 to 6 MeV. The neutron dosage was determined by the activation of iron, magnesium, and zinc foils as described by Cross (1963). The neutron dose rate was 33 rad/min.

After irradiation, the pupae were removed from the chambers and placed in 3-oz. cups containing 50 ml of water. The cups were then placed in aluminum frame cages covered with tubular gauze. When the adults emerged they were provided with 10 percent sugar water and allowed to mate. After 4 days the males were removed and the mated irradiated females offered a blood meal (1-14 day-old chicken). The irradiated males were then placed in cages with 50 unirradiated virgin

<sup>1</sup> Mention of a pesticide or a proprietary product does not constitute a recommendation or an endorsement by the U. S. Department of Agriculture.

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females, allowed to mate, and the mated unirradiated females were then offered a blood meal. Then beginning 3 to 4 days after blood meals, paper cups containing the oviposition medium, liver-yeast infusion, were placed in the cages of females each night for 1 week. Every morning, all egg rafts deposited were removed, placed in individual cups, and held for 3 days to allow for hatching. Sterility was determined by comparing the number of unhatched eggs with the total number of eggs laid. The rearing rooms were maintained at  $27^{\circ} \pm 1^{\circ} \text{C}$ .

**RESULTS AND DISCUSSION.** The sterility produced by gamma rays and neutrons is reported in Table 1. Results are based on a minimum of 2 tests. Oviposition was completely inhibited by 2000 rad from neutrons and 7500 R from gamma rays. When both sexes were irradiated, 750 rad from neutrons gave 95.4 percent sterility compared with 94.6 percent sterility produced by 5000 R from gamma rays. When irradiated males were mated with unirradiated

virgin females, 2000 rad from neutrons gave 99.5 percent sterility compared with 99.8 percent sterility produced by 7500 R from gamma rays.

Since the doses of both types of irradiation that stopped oviposition also produced comparable male sterility, neutrons appear to have a relative biological effectiveness (RBE) of 3.75. However, when both sexes were irradiated with 750 rad from neutrons and 5000 R from gamma rays, comparable amounts of sterility were produced which indicates an RBE of 6.67. These RBE values are lower than those (6.7-10) reported by Smittle *et al.* (1971) when they compared the effect of neutrons and gamma rays on house flies, *Musca domestica* L. However, they are similar to those reported by Alexander (1958) when she compared the effect of fission neutrons and 200 kV X-rays on *Drosophila* and found that neutrons had an RBE of 6.6 for sperm cells and 3.2 for spermatids.

TABLE 1.—Sterility of mosquitoes exposed to fast neutrons or to gamma rays as pupae (I = irradiated; U = unirradiated).

Dose	Percent sterility	
	I males X I females	I males X U females
	Neutron (rad)	
400	73.1	42.6
500	46.0	31.7
750	95.4	82.3
1000	100.0	86.0
2000	N.O. <sup>a</sup>	99.5
0 (check)	6.4	10.0
	Gamma (R)	
3000	44.0	58.0
5000	94.6	62.7
7500	N.O.	99.8
10,000	N.O.	100.0
0 (check)	10.6	5.3

<sup>a</sup> No oviposition.

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