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EFFECT OF GAMMA-RADIATED MALES ON EGG PRODUCTION IN *ACARUS SIRO*

EWA SZLENDAK AND JAN BOCZEK
Department of Applied Entomology
Agricultural University of Warsaw
Nowoursynowska 166,
POLAND
AND

WILLIAM BRUCE AND ROBERT DAVIS
Stored-Product Insects Research and Development Laboratory
Agricultural Research Service, USDA
Savannah, Georgia 31403, U.S.A.

ABSTRACT

Mating of unirradiated *Acarus siro* L. females with normal and gamma irradiated males was studied. Females usually laid eggs throughout their life span if they were mated at least once a week with normal males. Females paired with treated males contained spermatophores but did not lay any eggs. Previously mated fertile females of *A. siro* subsequently mated with irradiated, sterilized males ceased egg-laying during the next 1-2 weeks. There was no significant difference when compared to the untreated control in the number of eggs laid when females were mated for one week with irradiated males and then with normal males. Weekly alternation of

mating with irradiated and normal males reduced significantly the number of eggs laid by the females and significantly reduced their longevity. Because this mite species mates many times during its life span, it is doubtful that it could be eradicated solely by the introduction of sterile males into a natural population. However, the presence of such males would decrease the number of eggs laid by normal females and it would lead to the decrease in the number of offspring in the next generation.

RESUMEN

Se estudió el apareamiento de hembras de *Acarus siro* L. no-irradiadas con normales y de machos irradiados con rayos gamma. Las hembras usualmente depositan los huevos a través de su ciclo vida si se aparean con fachos normales por lo menos una vez por semana. Hembras apareadas con machos expuestos contenían espermatoforas, pero no pusieron huevos. Previamente apareadas hembras fertiles de *A. siro* y apareadas subsequentemente con machos irradiados y esterilizados, cesaron de poner huevos durante las siguientes 1-2 semanas. No hubo diferencia en el número de huevos puestos entre el testigo y las hembras apareadas por una semana con machos irradiados y después con machos normales. Alternando semanalmente apareamientos con machos irradiados y normales, redujo significativamente el número de huevos puestos por hembras y su logevidad. Debido a que esta especie de ácaro se aparea muchas veces durante su vida, es dudoso que pueda ser erradicado en una población natural solamente con la introducción de machos esteriles. Sin embargo la presencia de tales machos disminuiría el número de huevos puestos por hembras normales, lo cual traería una disminución en el número de la prole de la generación siguiente.

The grain mite, *Acarus siro* L., is an important cosmopolitan pest of grain and grain products. Studies on the radiosensitivity of the various stages of this species and the effects of ionizing radiation on its reproductive potential determined that ionizing radiation can kill, reduce fertility and/or sterilize this species (Burkholder et al. 1966, Brown and Davis 1969 and 1972, Davis 1972, and Hemenway and Davis 1972). This was considered to be a result of polyandry that allowed residual fertile males to neutralize any effect of the sterile males. The aim of this work was to check the effect of sterile males on the reproduction of the population.

This paper reports the results of a study to determine if sterilization of a portion of the grain-mite male population offers any potential as a control mechanism.

MATERIALS AND METHODS

All grain mites used in this study were from stock colonies at the Agricultural University of Warsaw, Poland. These colonies are maintained on wheat germ at 25 ± 1°C and 89% RH. All tests were conducted under these same environmental conditions. Inert deutonymphs were selected from stock colonies and placed into individual glass cages with wheat germ as food. The next day, the adults that emerged were sexed and irradiated with 60 krad in a 60 Co irradiator at 128 rad/sec. The selection of 60 krad was made because Brown and Davis (1969) found 50 krad to be an effective sterilizing dose for males for population control. Virgin adults were then paired in the following combinations:

A—untreated (U) female with U male (control);
B—U female with U male together for 7 days, then male discarded;
C—U female with U male together for 7 days, male then replaced with U male;
D—U female with treated (T) male;
E—U female with T male for 7 days, male then discarded;
F—U female with U male for 7 days, male then discarded and replaced with T male;
G—U female with T made for 7 days, then male discarded and replaced with U male;
H—U female paired alternately with a T and a U male every other week;
I—U female paired alternately with a U and a T male every other week.

In pairing combinations H and I, all mites in each set of pairings were the same age. Fecundity was determined by counting and discarding eggs each week. At least twenty-two pairings were used in each combination.

Results and Discussion

Female grain mites in mating conditions B lived the longest (Table 1), but not significantly longer than those in conditions A, D, E, F, and G. Mites subjected to mating conditions H and I had a significantly shorter mean lifetime than those in all other test conditions. This situation may be a result of repeated copulation with the males (harassment) as noted by Boczek (1957). The means of egg production for conditions A, B, and C were not significantly different. Males sterilized by irradiation transfer spermatophores when mating (unpublished results), but the females never were observed to lay eggs (Table 1D and E). In earlier tests, mites treated with the same dose laid singular eggs.

Females which were mated with untreated males at least once a week (A and C) usually laid eggs continuously throughout their lives (Table 2). Boczek (1957) found that female grain mites had their maximum egg production with one mating per week; with mating conditions B and F, sig-

TABLE 1. Longevity and oviposition of female *Acarus siro* as affected by nine mating conditions. Results are means resulting from 22-35 male/female pairings.[1]

Mating Condition	Longevity (weeks)	Oviposition (# of eggs)
A	4.8 [a,b]	119.3 [a]
B	5.6 [a]	97.7 [a,b]
C	4.4 [b,c]	122.0 [a]
D	5.1 [a,b]	— [2]
E	5.2 [a,b]	— [2]
F	5.2 [a,b]	64.9 [c,d]
G	4.8 [a,b]	82.6 [b,c]
H	3.7 [c]	40.5 [d]
I	3.7 [c]	73.9 [b,c]

[1]Means followed with the same superscript are not significantly different at the 5% level.
[2]No eggs were laid; not included in analysis.

TABLE 2. MEAN NUMBER OF EGGS LAID PER WEEK BY *Acarus siro* AS A RESULT OF NINE DIFFERENT MATING CONDITIONS.

Week	Condition A	B	C	F	G	H	I
1	45.2 [a]	56.1 [a]	49.5 [a]	46.3 [a]	0.0 [c]	0.0 [c]	45.6 [a]
2	33.0 [a,b]	40.5 [b]	30.0 [a,b]	16.4 [b]	46.6 [a]	25.8 [a]	9.2 [b]
3	26.4 [a,b,c]	1.5 [c]	23.3 [a,b]	1.7 [b]	21.2 [b]	4.6 [b,c]	15.8 [b]
4	10.0 [b,c]	0.4 [c]	25.3 [a,b]	0.5 [b]	22.1 [b]	18.6 [a]	3.8 [b]
5	5.9 [c]	0.0 [c]	7.4 [b]	0.3 [b]	4.5 [c]	2.4 [c]	13.6 [b]
6	2.5 [c]	0.0 [c]	3.3 [b]	0.0 [b]	10.7 [b,c]	16.8 [a]	2.7 [b]
7	2.0 [c]	0.0 [c]	5.5 [b]	0.0 [b]	2.5 [c]	0.0 [c]	0.0 [c]
8	0.0 [c]	0.0 [c]	2.0 [b]	0.0 [b]	1.5 [c]		
9		0.0 [c]		0.0 [b]	0.0 [c]		

[1]Means followed with the same superscript letter within a column are not significantly different at the 5% level.

nificant reductions in egg production occurred after removal of the untreated male. In 1977, Griffiths and Boczek observed in this mite that several matings can occur within one week resulting in the placement of several spermatophores in the female spermatheca. It appears from conditions B, H, and I that such a surplus of spermatophores will only provide viable sperm for slightly more than one week at a near maximum rate of egg laying.

The overall fecundity of the females in test condition G was little affected by an initial pairing with a treated male when total number of eggs is compared with test condition A (control). The introduction alternatively of treated and untreated males on a weekly schedule (test conditions H and I) caused increases and decreases in egg laying that, in most instances, were significant and were related to the kind of male used (Table 2).

The use of introduced sterile males to control a population of the grain mite would be questionable. The level of control would be dependent upon the ratio of sterile to normal males achieved within the population and the duration this ratio was maintained. Brown and Davis (1969) found that sublethal doses of gamma radiation could be used to cause a distinct reduction in grain mite populations, but eradication was questioned.

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FALL ARMYWORM (LEPIDOPTERA: NOCTUIDAE): FIELD SURVIVAL OF F_1 LARVAE FROM PARTIALLY STERILE PARENTS

J. E. CARPENTER, J. R. YOUNG, AND A. N. SPARKS
Insect Biology and Population Management Research Laboratory,
USDA-ARS,
Tifton, GA 31793

ABSTRACT

Fall armyworm, *Spodoptera frugiperda* (J. E. Smith), larvae from both irradiated (10 krad) and normal parents were compared for their ability to survive under field conditions on whorl-stage sweet corn and under laboratory conditions on a meridic diet. Survival rates for F_1 larvae from irradiated and normal parents were similar under laboratory and field conditions. Implications of the use of inherited sterility for the control of fall armyworm are discussed.

RESUMEN

Larvas del cogollero, *Spodoptera frugiperda* (J. E. Smith), de padres irradiados (10 krad), fueron comparadas por la habilidad de sobrevivir bajo condiciones de campo en la etapa verticular del maiz dulce y bajo condiciones de laboratorio en una dieta merídica. Grados de sobreviviencia de larvas F_1 de padres irradiados y de padres normales fueron similares bajo condiciones de laboratorio y de campo. Se discuten las implicaciones del uso de esterilidad hereditaria para el control del cogollero.

The potential of inherited sterility as a component of area-wide management of the fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith), was suggested by Knipling (1980) and later demonstrated in laboratory studies by Carpenter et al. (1983). These researchers used a theoretical model to aid in understanding the potential effect of persistent genetic suppressive action through several successive generations and concluded that males irradiated with a substerilizing dose (10 krad) would be 6.7 times more effective in suppressing FAW reproduction than completely sterile males. One assumption of the theoretical model was that the magnitude of deleterious effects during the growth and development of the F_1 generation