

COMBINED EFFECTS OF OXYGEN, PARTIAL VACUUM, TEMPERATURE, HUMIDITY AND GAMMA RADIATION ON MATING COMPETITIVENESS OF  
*CULEX PIPIENS COMPLEX* L. MALES

By

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التأثير المزدوج للأوكسجين والتفريغ الجزئي والحرارة والرطوبة  
مع أشعة جاما على التنافس التسافدي لذكور  
الكيولكس بيننز

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عندما عرضت عذارى ذكور بعوضة الكيولكس بيننز لأشعة جاما ( ٦٠ جراي ) أو الاكسجين أو التفريغ الجزئي ( ٠.١ تورشيلي ) أو الحرارة المنخفضة ( ١٠ م ) لمدة ساعتين أو للرطوبة النسبية ( ٣١٪ ) لمدة ٣ ساعات ، كل على حدة ، لم يتأثر التنافس التسافدي لهذه الذكور . ولكنه عندما عرضت هذه العذارى للعامل الثاني أو الثالث أو الرابع متبوعاً بالتشعيع بأشعة جاما ( ٦٠ جراي ) بعد نصف ساعة أو ساعة أو ساعتين ، انخفض التزاوج التسافدي انخفاضاً غير محسوس بينما كان الانخفاض محسوساً عندما عرضت العذارى للرطوبة النسبية ( ٣١٪ ) لمدة ٣ ساعات ثم شععت مباشرة أو بعد نصف ساعة أو ساعة أو ساعتين .

*Key Words:* Gamma radiation, oxygen, partial vacuum, temperature, humidity, *Culex pipiens*.

ABSTRACT

When the pupal stage of *Culex pipiens* complex L. male mosquito was exposed to gamma radiation (60 Gy), oxygen, partial vacuum (0.1 torr), low temperature (10°C), for one or two hours, or low humidity (31% R. H.) for 3 hours, applied separately, their mating competitiveness was not affected. However, when they were exposed to the 2nd, 3rd or 4th factor followed by irradiation with 60 Gy gamma radiation after 1/2, 1 or 2 hours, the mating competitiveness was insignificantly decreased. When the pupae were exposed to low humidity (31% R.H.) for 3 hours and then irradiated immediately or after 1/2, 1 or 2 hours, the mating competitiveness was significantly decreased.

INTRODUCTION

The combined effects of gamma radiation and some other factors on insects were investigated in trials to minimize the adverse effect of gamma radiation applied to sterilize these insects (Wakid *et al.*, 1973; Ogah and Juma, 1979 and El-Gazzar, 1983). In the present work, some physical stresses were applied to *Culex pipiens complex* pupae before irradiation to study the effect of their combinations on the mating competitiveness of the emerged males when caged with normal males and females in a ratio of 1:1:1. This work is a continuation to the previous work on the same species (Hafez *et al.*, (1993); Wakid *et al.*, (1993) and Abdel-Rahman

*et al.*, 1992). This series of investigations are being carried out hoping to increase the efficiency of the sterilized males by combining radiation with one of the physical stresses studied. Oxygen, partial vacuum' low temperature and low humidity were used for this purpose.

MATERIALS AND METHODS

Rearing, irradiation, statistical analysis and treating techniques described by Hafez *et al.* (1993), and Wakid *et al.* (1993) were followed.

Newly formed pupae were treated by gamma radiation (60

Gy) alone, by each factor for the chosen time alone (oxygen for 1 or 2 hours, 0.1 torr partial vacuum for or 2 hours, 10°C for 1 or 2 hours and 31% R.H. for 3 hours), or by each of the factors followed by irradiation (60 Gy) immediately or after 1/2, 1 or 2 hours). Mixed populations were made from treated and untreated males caged with untreated virgin females at the ratio 1:1:1.

The criterion for the effectiveness of sterile mosquito males was the reduction in the numbers of viable eggs resulting from females caged with both treated and untreated males. In every experiment, twenty treated males and twenty untreated males were caged with twenty untreated virgin females, to assess the observed hatchability of the laid eggs. Twenty untreated males were caged with 20 untreated females to test the natural sterility of the untreated males, 20 treated males were caged with 20 untreated virgin females to test the fertility of the treated males.

In all combinations, males and females were caged together in the morning so that sufficient orientation time could elapse before the evening mating period to prevent either the treated or the untreated males from having a mating advantage.

The competing adults were given the usual food (sugar solution and blood meals). The number of oviposited eggs and the percentage of hatching were daily recorded for every population.

Three replicates were made for each combination ratio.

### RESULTS AND DISCUSSION

Figures 1-4 represent the actual and expected percentages of egg hatchability at the ratio 1 T♂ : 1 N♂ : 1 N♀.

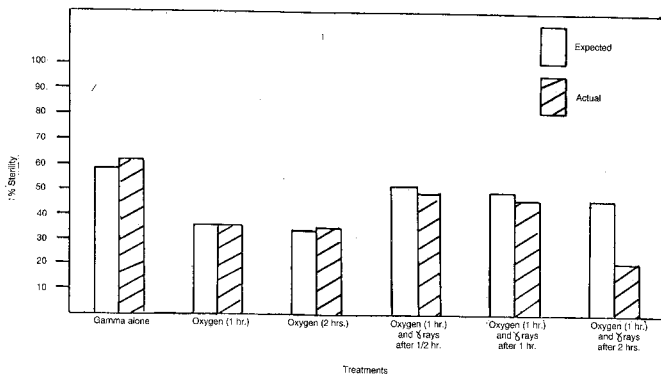


Fig. 1: Effects of oxygen, gamma radiation or both on the percentage observed and expected sterility of the competitive populations of *Culex pipiens* (treated as pupae) at the ratio 1 T♂ : 1 N♂ : 1 N♀.

It was found that, when normal males mated with normal females (control) the average percentage of hatching ranged from 78.17-81.99% (i.e., the normal sterility ranged from 21.83-18.01%). On the other hand, when males treated as pupae by gamma irradiation (60 Gy) alone and mated with normal females, the sterility ranged between 91.57 and 97.50%. However, when mating competitiveness of irradiated males was assessed as percentage of egg hatch, the actual values obtained at ratio of 1 T♂ : 1 N♂ : 1 N♀ ranged from 38.93-45.93%, which was in some populations lower and in others higher than expected, but all differences were not significant.

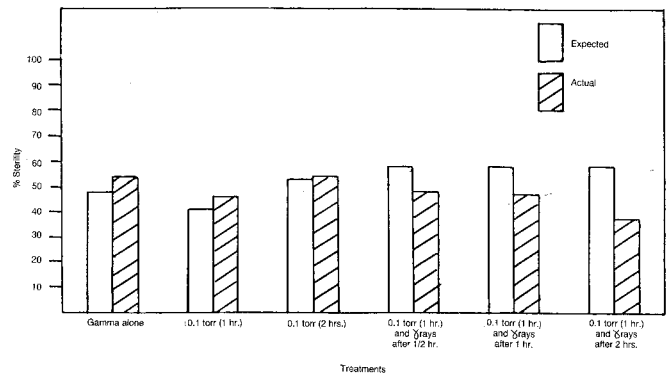


Fig. 2: Effects of partial vacuum (0.1 torr), gamma radiation or both on the percentage observed and expected sterility of the competitive populations of *Culex pipiens* (treated as pupae) at the ratio 1 T♂ : 1 N♂ : 1 N♀.

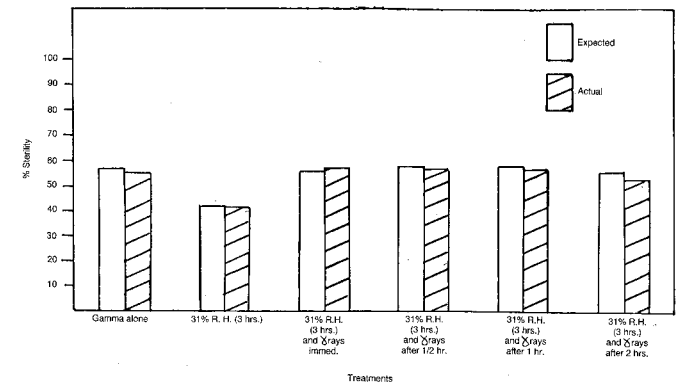
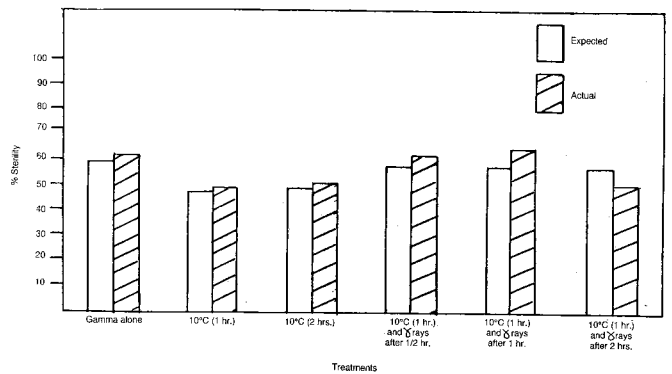


Fig. 4: Effects of humidity, gamma radiation or both on the percentage observed and expected sterility of the competitive populations of *Culex pipiens* (treated as pupae) at the ratio 1 T♂ : 1 N♂ : 1 N♀.

When males treated at the pupal stage with gamma radiation, oxygen, partial vacuum or low temperature for one or two hours alone, the average percentage of actual hatching were slightly lower than those expected. On the other side, when males emerged from pupae exposed to low humidity (31% R. H.) for three hours alone, the actual values of egg

hatch under the ratio of 1:1:1 were almost as expected. Therefore, the competitiveness of *Culex pipiens* males was not affected by exposure of pupae to any of the factors alone as the differences were insignificant.

The results showed also that the use of gamma radiation after exposure to oxygen, partial vacuum or humidity seemed to decrease the male competitiveness, as the actual percentages of egg hatch were more than expected at a ratio of 1:1:1. However, this decrease was statistically significant only in the oxygen treatments, that were followed by gamma radiation.

These results were encouraging and would offer an expected success in the use of the sterile insect technique after exposure to oxygen gas or treatments with either partial vacuum, low temperature or low humidity to suppress the population of the mosquito. This situation was reported on *Aedes aegypti* population since it was reported by Ogah and Juma (1979), that, males of this species were sterilized by irradiation in a nitrogen atmosphere and released at the rate of 1260 insects daily over a period of 62 days at Erewani, a small village in Kenya. However, the average fertility rate remained above 50%. Such effects were also studied by El-Gazzar *et al.* (1983) on *Culex quinquefasciatus* Say. After exposure of pupae 20-26 h old and adults 0-20 h old to gamma radiation from 137 Cs. in air and nitrogen. They reported that, the presence of nitrogen protected both stages against the induction of sterility. After treatment in nitrogen, the exposure required for 98% sterility had to be increased from 8 k rad in air to 29 k rad. At lower irradiation dosages, nitrogen offered more protection of genetic tissues to pupae than to adults. However, no improvement was observed in mating competitiveness when air was replaced by nitrogen during pupal irradiation, and only marginal improvement was observed after adult exposure. They added that, because of its deleterious effects on male competitiveness, irradiation might have limited usefulness as a method of sterilization for the mosquito. This result agreed with the result obtained by Wakid (1973) on *Ceratitis capitata* (Wied.) who arrived to the result that when males were irradiated either in the late pupal (2 days before eclosion) or the adult stage (1 to 24 hours old) with 7, 9 and 11 krad in air and in nitrogen, exposure to nitrogen before and during irradiation decreased sterility. No significant differences in sterility were found among nitrogen exposure periods of 5, 15, 25 or 35 minutes before irradiation. However, he found that, competitiveness of males irradiated as adults was found significantly less than that of males irradiated as pupae.

On the other side, the effect of combining radiation with low temperature on mating competitiveness was studied on *Ceratitis capitata* by Amin *et al.*, (1982). They reported that the percentages of actual egg hatch at the ratio of 3 treated males: 1 normal male : 1 normal female, were higher than the expected egg hatch in all treatments. However, they added that the male mating competitiveness was better when the pupae were incubated at 5 or 15°C for two days rather than for two hours.

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