The effects of gamma radiation on the reproduction of the cowpea weevil, *Callosobruchus maculatus* F. (Coleoptera - Bruchidae).

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Summary

Irradiation of the cowpea weevil Callosobruchus maculatus *F. was carried out to study its effects on reproduction. Complete sterility of males and females is obtained when treated as adults with 10 krad. At lower doses the female is more susceptible than the male. The fecundity is affected and at doses above 100 krad death occurs before the female lays all her mature eggs. The sterility induced is observed in the reduction in percentage of egg hatch, but mortality after hatching is negligible. When females are exposed to substerilizing doses as pupae or adults, the fertility on the first day of oviposition is significantly reduced and those treated as adults are the most affected. On the second day there is improvement in fertility.*

Résumé

Cette étude porte sur les effets des rayons Gamma sur la reproduction de Callosobruchus maculatus *F. insecte nuisible aux graines de niébé,* Vigna unguiculata *Wild stockées. L'irradiation des adultes à une dose de 10 krad provoque la stérilisation des mâles et des femelles. A des doses inférieures les femelles sont plus sensibles que les mâles : dès 1 krad la fertilité est réduite de 50% pour les mâles et de 70% pour les femelles. La stérilité induite s'observe par la réduction en pourcentage d'œufs éclos, mais la mortalité après l'éclosion est négligeable. La fécondité diminue avec l'augmentation de la dose, mais le processus de ponte est moins sensible au rayonnement puisqu'à 50 krad il y a ponte par toutes les femelles. L'irradiation des femelles aux stades adulte ou pupe avec des doses substérilisantes montre que les pupes sont moins radiosensibles que les adultes. Après une chute très significative de la fertilité au premier jour de ponte, la fertilité augmente au deuxième jour.*

Introduction

Reports by various workers (2,5,6,8,10,12) show differences in the response of bruchids to radiation sterilization. These differences can be attributed to differences between species as shown in the studies on *Sitophilus* species (3) and *Tribolium* species (1), and to differences between strains as reported in another study by Cornwell (4) on *Sitophilus granarius*. The study reported here was carried out on the response of the cowpea weevil, *Callosobruchus maculatus* to radiation sterilization. In Cameroon the cowpea weevil is the major pest of cowpea, *Vigna unguiculata* Wild during storage.

Material and Methods

During rearing and observation the insects were kept at 30 ± 1°C and 70 ± 5% R.H. The cowpea weevils were obtained from laboratory cultures reared on black-eyed cowpea during several generations. Virgin adults were obtained by putting infested grains singly in plastic capsules. Grains in which one insect only was allowed to develop were used and adults were collected within 4 hours after emergence. Virgin insects contained in glass bottles closed with a lid of fine netting were irradiated in a cobalt 60 irradiator. The following doses were used for irradiation:

— 1 to 10 krad in one krad increments.
— 15, 20, 30, 40, 50, 100 and 150 krad.

Test insects were paired immediately after irradiation and kept in petri dishes containing cowpea. Couples were set up in the following manner:

— Irradiated female + Irradiated male
— Irradiated female + Non-irradiated male
— Non-irradiated female + Irradiated male
— Non-irradiated female + Non-irradiated male

Ten days after pairing the cowpea grains were examined and the eggs that had hatched in each dish were counted. The adults that emerged within 30 days after pairing were collected and counted. The total number of eggs laid by irradiated females paired with non-irradiated males was determined and was used to evaluate the effect of irradiation on fecundity. To determine the effect of irradiation on the fertility of eggs laid on successive days by irradiated females, pupae and freshly emerged females were irradiated with one and two krad which were observed to be substerilizing doses. Each virgin irradiated female was paired with a freshly emerged unmated non-irradiated male. Each test pair was left in a petri dish containing cowpea. The males were discarded the following day so as to eliminate the possibility of retarded mating which will affect normal oviposition. The females were transferred on the second day and on each successive day into petri dishes containing clean cowpea. They were left in the fourth petri dish where they oviposited until they died. The total number of eggs laid and the number of eggs that hatched were recorded. Each treatment was made with 30 females and was repeated 3 times.

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TABLE 1

The effect of irradiation on the total number of hatched eggs produced by 30 pairs of adults when an irradiated (I) or non-irradiated (N) male was paired with an irradiated or non-irradiated female.

Female		Male	Dose (krad)										
			0	1	2	3	4	5	6	7	8	9	10
I	+	I	2157	420	122	19	11	4	2	0	0	0	0
I	+	N		602	247	140	78	28	14	8	7	1	0
N	+	I		1080	676	428	193	55	22	7	9	2	0

Results and Discussions

Fecundity: All the females irradiated at doses ranging from 1 to 50 krad laid eggs but only 93% and 60% of them did so at 100 and 150 krad respectively. The mean fecundity was about 74 eggs per female in the control and 1 krad treatments then it decreased with increase in treatment dose; 60, 31, 14 and 2 eggs were obtained per female at 10, 50, 100 and 150 krad respectively. Figure 1 shows the estimated linear regression line between fecundity and dose. The analysis of the regression gave a significant correlation (r = 0.9655) between fecundity and the exposure dose.

Fertility: The number of hatched eggs varied with the parent combination and with the treatment dose as shown in figure 2. For each of these doses the number of hatched eggs was highest if only the male was irradiated then decreased if only the female was irradiated and was least if both parents had been irradiated.

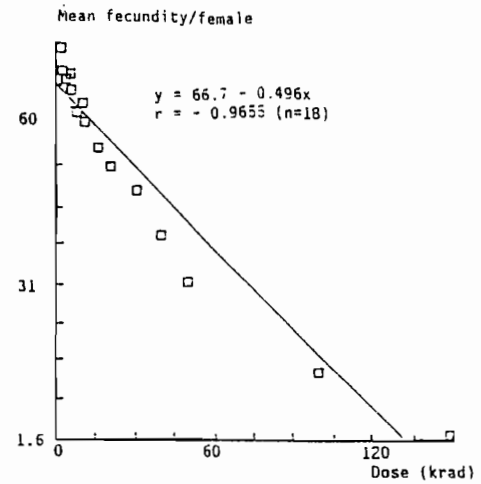

Figure 1 — The estimated linear regression between fecundity and dose.

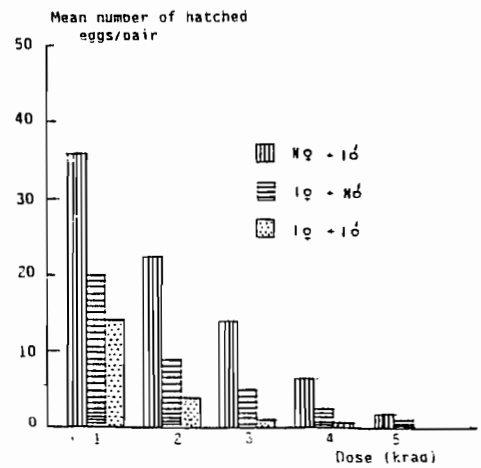

Figure 2 — The hatching of eggs laid by adults treated at emergence as effected by the pairing of an irradiated (I) and an untreated (N) male and female.

When both parents were irradiated no eggs hatched in the 7 krad treatment while hatching was prevented if only one of the parents was irradiated at 10 krad. The number of eggs hatched decreased significantly with increasing doses. The minimum doses at which no adults resulted were lower than those required to prevent hatching. The data in table 1 shows that no adults emerged at 6 and 9 krad when both parents or only one of them was irradiated respectively.

Fertility on successive days: Table 2 shows that the fertility on successive days of oviposition varied with the dose and with the stage at which they were irradiated.

TABLE 2

The fertility (% egg hatch) on successive days of oviposition of females irradiated as pupae or at emergence with substerilizing doses.

Treatment		Day of oviposition			
Age	Dose (krad)	1	2	3	4-death
Pupa	1	57.7	62.3	73.4	71.6
	2	26.6	31.3	38.3	61.2
Adult	1	11.0	58.0	44.0	40.0
	2	5.0	22.0	9.0	6.0
Control	0	95.0	89.4	91.5	92.4

The egg hatch in the control was about 90% or more on each day of oviposition whereas it was significantly lower in all the irradiated treatments. Females irradiated as pupae had higher fertility compared to females irradiated as adults. In either case the fertility was lower in the 2 krad treatment than in the 1 krad treatment. Generally the fertility increased after the first day of oviposition. The survival of adults from the hatched eggs in the different treatments was very high.

From the results obtained it is evident that gamma radiation affects the fecundity and fertility. At doses of 100 krad and above, the effects of irradiation on survival will indirectly affect oviposition, few or no eggs will be laid; death will occur before the female lays all the mature eggs. Substerilizing doses cause deletarious mutations which can be lethal, semilethal or sublethal. This will result in the infertility of some eggs which will not hatch or death may occur during development so that the fertility, based on adult emergence, is lower than that based on egg hatch. Von Borstel (11) explains that the degree of repair of the reproductive cells vary with the stage of development of the egg and the stages of oogenesis and spermatogenesis respond with unequal sensitivity to radiation. The greater resistance of males than females which has also been reported by some authors (7,9) shows the greater susceptibility of ovules than sperms to radiation sterilization. Differences in the susceptibility of individual cells will account for the recovery in fertility. The younger ovocytes which are probably more resistant also have a longer time during which radiation damage is repaired so that pupae are more resistant than adults to radiation sterilization.

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