GAMMA IRRADIATION EFFECTS ON SITOPHILUS ORYZAE L.

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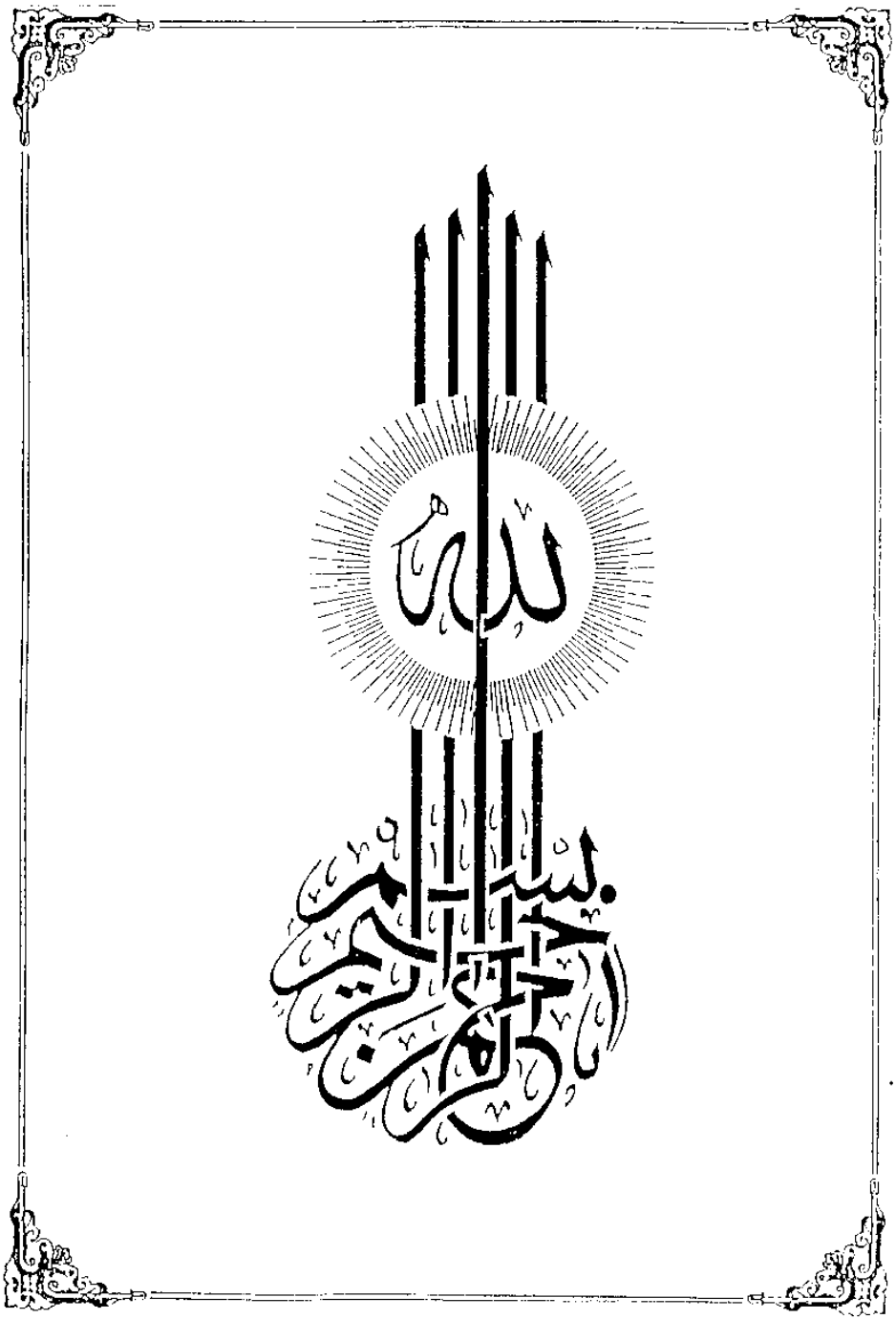

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INTRODUCTION

INTRODUCTION

The rice weevil: Sitophilus oryzae L. is considered to be one of the most wide spread stored product insects. This weevil is capable of penetrating and remaining in the healthy grains, and also it is capable to propagate and live on grain products.

The efficient control and removal of insects from food commodities has long been the goal of producers and processors. Fumigation, though by far, the most effective method of grain disinfestation has its own serious limitations. Chemical treatments, in some cases, may create problems by leaving undesirable residues. Also, the development of resistance to insecticides by insects is yet another motive to develop alternate methods for pest control. Irradiation techniques seem to offer solutions that are desirable in many respects;

The prospect of commercial grain disinfestation by gamma radiation has created new interest in the basic mechanisms of development of insect resistance. Insects can be sterilized with lower doses of radiation than are needed for quick mortality, and these lower doses offer solutions that are desirable in many respects.

A great deal of information on radiation effects on stored product insects has now been accumulated. For the most part, however, the data are scattered and incomplete and much

of it is little more than qualitative observations. Most data are not strictly comparable because of difference in types of radiation used, exposure rates, and often poor dosimetry. In addition, it is now known that various pre and post-irradiation treatments or conditions profoundly affect the results obtained. Further problems arise because radio-sensitivity changes greatly through the course of an insects life cycle and may change drastically even within a single stage.

The earliest studies of radiation effects on stored-product insects were concerned with the Cigarette beetle, Lasioderma serricorne and the rice weevil, S. oryzae. Runner (1916) showed that eggs, larvae and adults of L. serricorne could be killed in cigars by X rays, but that doses required would be very large.

Radiation disinfestation of commodities is a relatively new field, and definite conclusions as to economic feasibility must wait further research and pilot plant studies. Two main types of units have been proposed. Some workers advocate electron accelerators with high grain flow rates and low penetrating power, while others favour radioisotopic sources for the more penetrating gamma rays such as Cobalt-60 or Cesium-137.

Suggestion have been made for mobile irradiation facilities installed in trucks, railroad, cars and ships.

by moving such facilities to locations where they are needed, maximum use can be made of the irradiator, and this proportionally reduces the unit cost.

The primary objective of the present study is to investigate the effect of gamma radiation on the different developmental stages of S. oryzae. If the comparative sensitivity between different stages can be determined, the dosages to kill the most resistant stage present can be regulated. The second purpose is to study the mating competitiveness between irradiated and unirradiated adults.

REVIEW OF LITERATURE

The present review, reports briefly, the influence of radioisotopes and ionizing radiations on some biological aspects of different insects. Special emphasis was made to their role in the induction of sterility and lethality in various species of insects and their applications in the control of insect population.

Potentially, all insect species that occur in stored products can be controlled by gamma radiation. There are, however, certain problems associated with the use of this method of control for commercial purposes. One of the major problems is to determine the minimum dosages of radiation needed to control the insects while keeping the cost of treatment at an economical level. Furthermore, the threshold of radiation that will produce quality changes in some commodities does not permit the use of higher dosages.

Insect populations in stored products can be controlled by producing immediate mortality or by producing sterility of the irradiated insects. Since the dosage level required for death in all metamorphic stages within 24 hours may be 15 or more times that required to produce sterility (Cornwell and Bull, 1960), the latter method appears to offer the greater promise under most conditions. However, in packaging plants where the primary concern is the destruction of eggs and young larvae, immediated insect mortality may be attainable, since

many workers have shown that eggs and larvae are considerably more susceptible to radiation damage than are the adults.

Dalmontes (1959) found that 6000 rep of gamma radiation destroyed corn and rice weevils: Calandra granaria and C. oryzae, respectively in 20 days and flour beetles Tribolium castaneum in 36 days after irradiation. At this level of radiation, no harmful chemical or organleptic changes could be found.

Bruel et al., (1960) studied the resistance of Sitophilus granarius and S. oryzae at different stages of their development to gamma irradiation (CO-60 source). They found that 1000 rad of gamma rays destroyed 99% of the eggs (2 days old) of S. oryzae, but with S. granarius 2500 rad was required to obtain 98% mortality. S. granarius showed a greater resistance to irradiation at all stages of development than S. oryzae, but the differences in resistance decreased at later stages.

In both species 5000 rad or more was required for complete sterilizing of adults.

Jefferies (1960) investigated the effects of continuous and fractionated doses of gamma rays on the survival and fertility of S. granarius. Survival of all developmental stages was significantly increased by fractionation, particulary with larvae and pupae. The difference in survival afforded by continuous and fractionated treatments must be attributed to recovery during the intervals between fractions. Recovery

was noted with intervals of 10 minutes and longer, the amount of recovery and final survival being governed by the number of fractions, fractional dose, interval time and interval temperature, but not by over all dose Rate of recovery was... greater in the first hours after irradiation and decreased with increasing number of fractions.

In studies with S. granarius and S. oryzae, Van Den Broucl et al., (1960) reported that the eggs were found to be the most and the pupae and adults the least susceptible stages in both species. A dose of 20 krad did not destroy all the pupae and adults in wheat grains. One of 1000 rad applied within two days of deposition prevented almost all the eggs of S. oryzae from giving rise to adults, but reduced the numbers of adults that developed from those of S. granarius. All stages of S. granarius except the pupae and young adults were more resistant than corresponding stages of S. oryzae. Irradiation of the first and second instare larvae of both species at 1000 rad had a little effect on the numbers and fertility of the adults. Irradiation at 2500 rad exerted a sterilizing effect on the adults, especially when applied to the second and third instar larvae of S. granarius and the third instar larvae, pupae and adults and to a lesser extent, the second instar larvae of S. oryzae, no adults were produced by eggs and first instar larvae of this species following irradiation at 250 rad. In both species a dose of 5000 rad prevented the development of adults when applied to the third instar larvae or to younger stages. This dose greatly reduced

the numbers that developed when applied to later stages virtually all the adults produced were sterile.

Dennis (1961) investigated the effects of gamma irradiation on certain species of stored product insects. An exposure to 100,800 rad at an average dose rate of 2400 rad/hour killed all Tribolium confusum adults and larvae, Oryzaphilus surinamensis adults, Rhizopertha dominica adults, S. granarius adults, S. oryzae adults, Plodia interpunctella larvae, and Ephestia cautella larvae within 2 months.

An exposure to 191200 killed O. surrinameisis adults, Tribolium adults and larvae and P. interpunctella within 6 days. Tribolium exposed to 8400 rad did not reproduce during a 2 month period after exposure.

Andreev et al., (1962) studied mortality, sterility and the reduction of the biological activity of the granary weevil Calandra granaria as affected by several doses of gamma radiation. Groups of insects were exposed to 1, 8, 12 and 20 krad of gamma radiation (CO-60 source). The results have indicated that exposure to doses between 0.5 and 1 krad exerts partial lethal and sterilizing action; complete sterilization obtained at about 8 krad.

Cornwell et al., (1962) studied the effect of sterile and substerile doses of gamma radiation on populations of S. granarius.

The dose of 16000 rad recommended for industrial applications of gamma radiation for the control of insects in grain is