EFFECT OF SUBLETHAL CONCENTRATIONS OF CO_2-AIR MIXTURE ON SOME BIOLOGICAL ASPECTS OF *SITOPHILUS ORYZAE* L.

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Abstract

four sublethal concentrations of CO_2 in air mixture were investigated to study their effects on some biological aspects of *S. oryzae*. The concentrations were 20%, 29%, 36% and 46% CO_2 in air mixture. The sublethal concentrations of CO_2 - air mixture had an obvious effect on the longevity, fecundity and reproductive capacity of the insect. The longevity females at all sublethal concentrations was shorter than males. As the sublethal concentration increased, the longevity of the survivor adults decreased. The number of eggs laid per female was greatly reduced as the concentration increased. The concentrations did not inhibit egg deposition. The reproductive capacity of *S. oryzae* (measured by the mean number of offspring per female) was considerably reduced by increasing the sublethal concentration of CO_2 to 46%. These studies were carried out on the progeny emerging from eggs exposed to the concentrations for 4 days.

INTRODUCTION

Several investigations were carried out in many parts of the world on the

effect of sublethal concentrations of CO_2 on the biological aspects of the stored grain insects (Bailey, 1965; El-Nahal and El-Halfawy 1973; Storey 1975, 1977, 1978 ; Hashem, 1981).

Lindgren and Vincent (1970) found that the development of immature stages of *Sitophilus granarius* L. and *Sitophilus oryzae* L. was delayed under pure Na_2 and CO_2. Press and Flaherty (1973) found a large reduction in the fecundity of the adults of *Ephestia Kuhniella* (Zeller), *Ephestia cautella* (Walker) and *Plodia interpunctella* (Hubner), when exposed to 96% CO_2 atmosphere for 2h per day during 6 successive days. They observed that the percentages of egg hatchability were only 2% in case of *E. cautella* and 5% in case of *P. interpunctella*, while it was entirely eliminated in *E. kuhiella.*

The present work is a study on the sublethal effects of CO_2 concentrations in air on some biological aspects of S. oryzae.

MATERIALS AND METHODS

The present work was undertaken on females emerging from eggs treated with 20%, 29%, 36% and 46% of CO_2 - air mixture at 25 ± 1°C and 65 ± 5% R. H. The biological aspects studied were the number of eggs laid per female, longevity and fertility.

The parental insects were obtained from a laboratory strain maintained at the Stored-Product Insects Research Centre, Ministry of Agriculture. Stock culture was set up by introducing 500 adults in a two pounds glass jar, half filled with wheat and covered with muslin, held in place by rubber bands (Sun, 1947). The adults were permitted to oviposit in these cultures for 48h and then removed by sieving. This process was maintained regularly until sufficient numbers of insects were obtained. The emerging aduts (about 500) were collected and released in two pounds glass jar, half filled with wheat. The adults were left to deposit eggs for 2 days, after which they were removed. Samlpes of wheat Kernels, that held 2-days old eggs were chosen from these cultures and used in exposure tests for sublethal CO_2 in atmosphere. The experimental unit was 3g wheat kernels. This unit was prepared in

a glass tube 7 cm long and 1.5 cm diameter covered in both ends with gauze. These tubes were introduced into a gas-washing bottle (dressel flask).

Grain kernels with egg stage in gastight connected dressel flask were held in constant temprature room at 30°C and exposed to the gas mixtures by leading gas out of the cylinder through copper tubes and a humidifying unit at 65% R. H. consisting of saturated $NaCl/H_2O$ solution into the flasks.

At the outlet of the flasks, O_2 content was determined continuously by axygen analyzer. After about 15 minutes (time for about 10 replacements of total flask volume by gas mixture) outlet concentration was identical with inlet concentration. The gastight sealed flasks were then separated from the gas mixture cylinder to permit further experiments with other flasks (Hashem, 1990).

After 4 days as exposure period, flasks were aerated and grain kernels were transferred to Petri-dish (5 cm diam.) in a culture room and examined for emerged adults at 25°C. Five pairs of the newly emerged adults from each treatment were prepared, each pair in a muslin covered plastic vial (5 cm long and 2.5 cm diam.) together with some grain kernels to serve as oviposition site. These grain kernels were changed daily so long as the female was alive by new ones and the removed kernels were incubated until emergence of adults. By this technique, it was possible to determine the total number of eggs laid and the total number of adults emerged per female. Each treatment had its control.

RESULTS AND DISCUSSION

Data shown in Table 1 indicate that as the concentration of CO_2 - air mixture increased, the mean longevity of *S. oryzae* adult decreased. A significant decrease in mean longevity of adults was also observed at 46% CO_2 as the duration of adult at this concentration was nearly 20% of the control. At all the sublethal concentrations of CO_2 - air mixture tested, the males lived slightly longer than females.

These results are in agreement with those of Storey (1975, 1977, 1978) who

Table 1. Effect of sublethal concentrations of CO_2 - air mixture on longevity and fecundity of the survivor adults of *S. oryzae* at 25°C and 65% R. H. (exposure period 4 days).

CO_2 conc. (%)	Longevity in days			Mean No. of eggs per female
	Male	Female	Mean	
20	82.2 + 3.3	76.6 + 2.9	79.4 + 3.1	169 + 5.1
29	49.4 + 1.2	46.8 + 0.9	48.1 + 1.05	122 + 2.4
36	28.2 + 0.2	27.0 + 0.3	27.6 + 0.25	70 + 1.1
46	16.4 + 0.4	13.4 + 0.5	14.0 + 0.45	34 + 1.1
Control	103.3 + 4.1	96.5 + 3.8	99.9 + 3.9	230 + 7.3

mentioned that exposure of *S. oryzae*, *S. granarius* and *Callosobruchus maculatus* F. to low oxygen atmosphere caused a delay in development and a decrease in longevity. Also Spratt (1979a) found that the longevities of males and females of *S. zeamais* were reduced as a result of contiinuous exposure to 10% O_2, 10% CO_2 and 80% N_2 at 39°C and 71% R. H.

The effect of various sublethal concentrations of CO_2 - air mixture on the fecundity of *S. oryzae* when the two sexes were exposed for 4 days are recorded in Table 1. The number of eggs laid per female was higher by 50% of the control at the concentrations 20% and 29% CO_2 . At 36% and 46% CO_2 , the number of eggs laid per female was greatly reduced. The sublethal concentrations of CO_2 - air mixture did not inhibit egg laying.

These results are in agreement with those of Press and Flaherty (1973) who found a large reduction in the fecundity of *Ephestia kuhniela* (Zeller), *Ephestia cautella* (Walker) and *Plodia interpunctella* (Hubner) when were exposed for 6 days to 96% CO_2 in atmosphere for 2 h. per day.

Table 2. Effect of sublethal concentrations of CO_2 - air mixture on reproductive capacity (number of offspring of survivors) of *S. oryzae* at 25°C and 65% R. H. (exposure period 4 days).

CO_2 conc. (%)	No. of offspring/10 females				
	CO_2 concentartion in air mixture (%)				
	20	29	36	46	Control
1st	100	68	60	18	136
2nd	337	214	122	62	475
3rd	433	274	131	70	619
Total	870	556	293	150	1230
No. of adult per female after 3 generations	87.0	55.6	29.3	15.0	123.0

As indicated in Table 2, the reproductive capacity (measured by the mean number of adult offspring per female) of *S. oryzae* was considerably reduced by increasing the concentration of CO_2 - air mixture to 46%. The mean number of offspring produced per female at this concentration was about 12.5% of the number produced by untreated females. This significant reduction in reproductive capacity was expressed by a significant decrease in number of eggs laid per female, in addition to reduction in percentage of egg hatching.

Spratt (1979b) found that exposure of *S. zeamais* to a gas mixture consisting of 10% O_2 , 10% CO_2 and 80% N_2 at 30°C and 71% R. H. during oviposition, development and during both periods had resulted in a decrease in the number of adult offspring per female.

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تأثير التركيزات تحت المميته لغاز ثانى أكسيد الكربون فى مخلوط الهواء على السلوك البيولوجى لحشرة سوسة الأرز

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أختبرت تأثيرات التركيزات تحت المميته لغاز ك أ٢ فى مخلوط الهواء على السلوك البيولوجى لحشرة سوسة الأرز . وقد كانت هذه التركيزات ٢٠ ، ٢٩ ، ٣٦ ، ٤٦ ٪ ك أ٢ فى مخاليط الهواء. وقد ظهر أن هذه التركيزات لها تأثير ملحوظ على طول فترة الحياه والخصوبه ومتوسط عدد البيض الذى تضعه الإناث. فقد تبين أن طول فترة حياة الإناث تحت كل هذه التركيزات التحت مميته كانت أقل من الذكور. وأنه بزيادة التركيز التحت مميت تقل فترة حياة الذكور. ويقل عدد البيض الذى تضعه الأنثى الواحده بزيادة التركيزات مع الأخذ فى الإعتبار أن هذه التركيزات لا تثبط أو تقلل من وضع البيض بالنسبه للإناث .

وكان متوسط عدد البيض الذى تضعه الأنثى فى حالة تعرضها لأعلى تركيز تحت مميت من الغاز (٤٦ ٪ ك أ٢) يقل بدرجه ملحوظه.

أجريت هذه الدراسات على خليه ناتجة من بيض سبق تعريضه للتركيزات التحت مميته السابق ذكرها لمدة تعريض قدرها ٤ أيام.