Nº of poster:172

Radiation Dose Responses of *Drosophila suzukii* (Matsumura) for Use in the Sterile Insect Technique (SIT)

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INTRODUCTION

The spotted wing drosophila *Drosophila suzukii* Matsumura (Diptera: Drosophilidae) (Fig. 1), a pest of berries an stone fruits, invaded North America and Europe in 2008. Current control methods rely mainly on insecticides. The sterile insect technique (SIT) has potential as an additional control tactic for the integrated management of *D. suzukii*. This study is part of a large research program that aims to determine the feasibility of using the SIT. The present objective is to quantify the effects of different gamma irradiation doses applied to *D. suzukii* pupae on several biological attributes of irradiated individuals and their descendant: emergence, deformed males, longevity, fecundity, fertility of parent and descendant flies.

Figure 1: Drosophila suzukii (J.P. Moisan-De Serres)

METHODS

- *Drosophila suzukii* colony was kept at 23 ± 1ºC, 50 ± 10% HR, and under a 16:8 L:D photoperiod. A carrot powder diet was used for emergence, deformation and longevity experiments (Mitchell et al. 1965) and a banana diet for F1 survival and F1 fertility experiments (Chabert et al. 2012).
- Four day-old *D. suzukii* pupae were irradiated in a 60Co Gamma Cell 220 (MDS Nordion, Canada) in IPCL and in a 137Cs Gamma Cell 3000 (Best Theratronics, Canada) in Canada. Experiments below were performed at : **30, 50, 70, 80, 90, 100 or 120 Gy**. Control pupae were not irradiated.
- **Emergence and deformed adults**: a total of 8,958 pupae were examined, ~3000 pupae from the control and ~800 pupae for each experimental doses.
- **Longevity**: upon emergence, 10 *D. suzukii* adults of the same sex were place in a 15 x 15 x 15 cm plastic cage with water, sugar and yeast. Mortality was recorded each day at 9 AM until all flies died.
- **Fecundity and F1 survival:** (1) 10 non-irradiated females mated with 10 irradiated males, (2) 10 irradiated females mated with 10 non-irradiated males and (3) 10 non-irradiated virgin females were placed in plastic cage with water, sugar, yeast, and an egg-laying site renewed three times a week (carrot diet covered with slices of banana). Egg-laying sites were observed to count the numbers of eggs per cage. Same experiment was made with banana diet as egg laying site and adult produced was recorded.
- **Fertility**: same set-up as in fecundity experiment but egg laid from 8 AM to 4 PM and from 4 PM to 8 AM were put on a black filter paper placed on a wet sponge. Eggs incubated at rearing conditions for 48 h were observed under a stereomicroscope for hatching.
- **F1 fertility**: Upon emergence, each descendants produced from pairs where the males had been irradiated at 70 Gy and higher was put individually in a 1 oz cup with 5 ml of banana diet and two non-irradiated adults of the opposite sex. The diet was changed three times during a ten-day period and incubated at rearing conditions to record the number of pupae produced.

RESULTS

- Emergence, deformed adults (Binomial GLM: F=0.2031, P=0.663 and F=0.3031, P=0.580 respectively) (Fig. 2) and longevity (Mantel-Cox log-rank: X^2=13.5, P=0.062 for males and X^2=5.2, P=0.635 for females) did not differed between doses. Males survived up to 36 days while females were up to 28 days.
- Dose did not have effect on fecundity of females mated with irradiated males (Linear mixed model, F=0.2290, P=0.634) whereas drastically reduced the fecundity of irradiated females (Poisson GLM, F=53.52, P<0.0001) (Fig. 3).
- Virgin females laid an average of 34 ± 40 sterile eggs/week/10 females;
- Egg hatch decreased exponentially with dose (Regression, pseudo-R^2= 0.93) from 82.6% with control to 4.0% with 120 Gy (Fig. 4).
- Survival from egg to adult of the F1 generation decreased exponentially with dose (Regression, pseudo-R^2 = 0.86) from 59.2% with control to 0.2% with 120 Gy (Fig. 5).
- F1 generation that reached the adult stage were fertile, regardless of the irradiation dose of the F0 (Table 1).

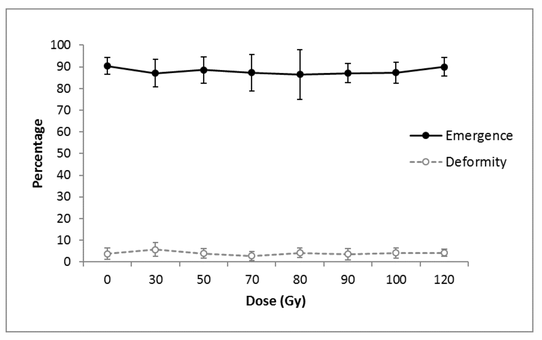

Figure 2. Effect of irradiation dose on percent D. suzukii adult emergence and percentage deformed adults.

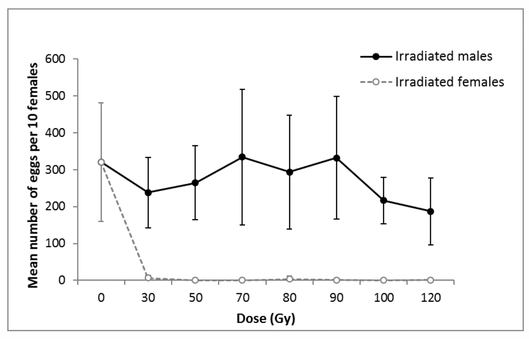

Figure 3: Effect of irradiation dose on D. suzukii fecundity when either males or females were irradiated.

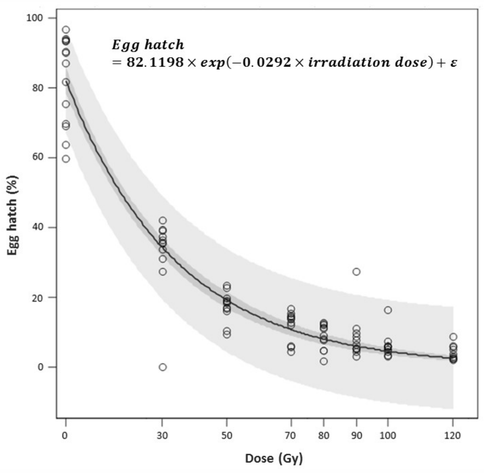

Figure 4. Effect of irradiation dose on egg hatch when non-irradiated D. suzukii females were mated with irradiated males. Dark areas = 95% confidence limits and pale areas=95% prediction limits.

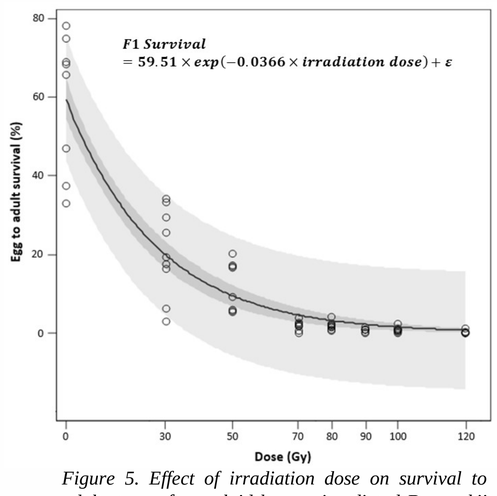

Figure 5. Effect of irradiation dose on survival to adult stage of eggs laid by non-irradiated D. suzukii females when mated with irradiated males. Dark areas = 95% confidence limits and pale areas=95% prediction limits.

Table 1: Effect of gamma irradiation dose applied to D. suzukii males on the fertility of males and females of the F1 generation..

Irradiation dose (Gy)	Descendants produced by females F1 (pupae ± SD)	n	Descendants produced by males F1 (pupae ± SD)	n
70	34.5 ± 28.5	4	46.5 ± 46.3	3
80	22.8 ± 21.0	5	46.0 ± 32.5	6
90	5.3 ± 5.51	3	9.7 ± 9.9	4
100	21.7 ± 28.2	3	64.9 ± 65.9	4
120	0	1	57.0	1

CONCLUSION

Gamma irradiation did not cause apparent morphological damage to males and females *D. suzukii*, even at the highest dose tested (120 Gy). This study is the first to consider the SIT as a control technique for *D. suzukii*. Irradiated sterile males are expected to mate with wild females and prevent them from producing descendants. Further research is required, for instance to examine competitiveness of irradiated males. Experiments have been undertaken to compare the mating behavior of irradiated and non-irradiated males in the laboratory when male are irradiated with 120 Gy.

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