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RESEARCH ARTICLE

STUDY ON THE PHYTOSANITARY TREATMENT OF HARVESTED LITCHI FRUITS AGAINST INFESTATION CONTROL OF THREE LEPIDOPTERIAN FRUIT BORERS

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ABSTRACT

Insects are more radio resistant than higher vertebrates. The sensitivity to radiation varies widely among the insects orders, e.g. some species sterilized at doses below 50Gy. While lepidoptera requires more than 400Gy (IDIDAS, 2010). The use of phytosanitary treatment for sterilize insects to control or eradicate insect pests population is a revolutionary initiative in entomology. Because phytosanitary treatment through radiation is effective against most insects at dose levels that do not affect the quality of fruits. It is the ideal technology to disinfestion while maintaining excellence of fruit quality. *Platypedla illepida*. *Platypepla ombordlta* and *Conmpomorpla sinensis* are internal feeding insect pests that typically infesting 15-30% of the litchi fruit crop. In the phytosanitary treatment rays from radioactive substances could induce genetic damage and a large number of dominant lethal mutations. Which were exposed through a reduction in the hatchability of the eggs laid by the treated males. The effect of radiation can be produce abnormalities, reduction of adult life span, flight ability, mating propensity, nutrition and ultimately death of the fruit borers. (FAO/1AEA/USDA, 2003)

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INTRODUCTION

During the summer season, litchi fruits provides a fundamental nutritional intake for huge population and therefore, are the main economic source of litchi cultivars. Fruit borers can be spread by marked chain or transporting infested fruit into or between markets. So the local and national market is also being deeply affected by fruit borers. In this situation phytosanitary treatment may be helpful to protect and increase market value of fruits. Each year partial packages of fruit from exporting states are intercepted, confiscated and destroyed in transporting because of these insects. Thereby causing major economic losses for many cultivar and exporters (Shah *et al*., 2014; Sarwar *et al*., 2015) India has an excellent potential for producing fresh litchi fruit crop that are exported but this can only be achieved with proper fruit borer control and phytosanitary treatment. If a consignment of fruits containing a single fruit infested by the lepidopterian larvae can exported elsewhere, the whole batch may be rejected. Fruit borers lay eggs in fruits, rendering produce inedible and devastating the fruits out of several lepidoptera species that attack litchi fruits *Platypepla illepida, Conompomorpha sinenisis* and *Platypepla ombordelta* are most harmful and even though some other species also causes economical losses. The life cycle of most lepidoptera is similar, female generally implants its eggs on the fruit of the host plant. But also in the young fruits which have fallen. The larvae develop (Fig. 2) in the pulp of fruit which provide opportunities for secondary infections when the larvae emerge from the fruit. The growth of the larvae accelerates the maturation of the fruit. Which detaches and falls from plants, upon emergence, pupae develop soon in adults and start looking for the nourishment needed to reach several maturity, copulate, lay eggs and continue their generation (Sarwar, *et al*., 2013; 2014a; 2014b). Safeguards of litchi fruit crops are required and enforced to prevent the spread of these lepidopterian fruit borers by regulating national and domestic movement of litchi fruits. Ranking among fruit crops with the highest global commercial value sapindaceous fruit crops have encompassing extensive basic research and studies on developing acceptable and efficacious probit-9 including pheromone traps, hot water immersion, fumigation irradiation treatments and achieving security from lepidopterian fruit borers. *Platypepla illepida, Platypepla ombordelta* and *Conompomorpha sinensis* attack litchi (Fig. 1) and other fruits in Bihar. Studies were undertaken whether irradiation phytosinatary treatment at 400 Gy (Table 1) an accepted treatment for disinfection of fruit borers in tropical fruit.

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Fig. 1. Infested Litchi Fruit

Platypepla illepida is determine to be more tolerant of radiation than *Platypepla ombordelta* and *C. sinensis* using the criterion of control in developing to the adult stage. The pattern of tolerance to phytosanitary treatment in *Platypepla illepida*, was generally eggs < early insects < late instars < pupae.

Table 1. Estimated sterilization doses reported for larvae or pupae of insects from different taxonomic orders (IDIDAS, 2010)

Order	Sterilization Doses (Gy)
Hemiptera	10-200
Hymenoptera	80-100
Thysanoptera	100-200
Lepidoptera	40-400
Diptera	10-200

MATERIALS AND METHODS

Phytosanitary treatment was done in the Lab of Aaditya Raj Para Medical College & Hospital by 5 Mev x-ray machine. The internal dimensions of the treatment chamber are 18 by 25 by 50cm. for irradiation treatment, eggs, larvae, pupae or adults in 50ml plastic cups with or without diet were packed and treated at the targeted doses. Spectrophometer were used to verify dose accuracy in each replication. All phytosanitary tests used laboratory reared *Platypepla illepida*, *Platypepla ombordelta* and *Conompomorpha sinensis* to identify the more tolerant species between said insects. Late (fourth and fifth) instars were eradicated with a target dose of 50-100Gy. This dose was choosen because it was known from preliminary test to be sub lethal. Each of two replicates had 50 individuals of each species and all replicates were treated on the same day. Percentage adult eclosion was the criterion used for selecting the most tolerant species. A single group of 50 late instars of each species was left untreated and held as controls. Based on the results of this study all subsequent tests focused on *Platypepla illepida*. Eggs (3rd day old) and larvae (neonates, 2nd/3rd instars and 4th/5th instars) were irradicated at targeted doses of 50, 100, 150, 250 and 400Gy. These are the stages that occurs in litchi fruits. After treatment, development of each individual in a test was followed until death. For each age-dose combination, individuals that developed to the adult stage were mated when possible. To examine irradiation effects on mating success, fecundity and fertility eggs were treated in Plastic cups and neonates emerging from treated eggs were treated in plastic cups with artificial diet. The efficacy of phytosinatary treatment against immature *Platypepla illepida* was evaluated, based on the number of treated individuals pupating, adult eclosion and adult female fecundity and fertility. Adult emergence data for the comparative study between *Platypepla illepida*, *Platypepla ombordelta* and *Conompomorpha sinensis* were collected and subjected to analysis.

Fig. 2 Larvae of *Platypepla illepida*

Fig. 3. Pupae of *Platypepla illepida*

RESULTS AND DISCUSSION

Using a dignostic x-ray dose of 50Gy, average, adult emergence was 34% for treated *Platypepla illepida* and 12% for treated *Platypepla ombordelta* and 9% for treated *Conompomorpha sinensis* which was highly average difference. Therefore, *Platypepla illepida* was focused for detail tests. Using the criterion of success in developing to the adult stage, the pattern of tolerance to x-ray radiation in *Platypepla illepida* was generally eggs < early instars < late < pupae (Table 2, 3 and 4). The most treatment stage occurring in harvested litchi fruit crop was late (4th and 5th) instars (Table 3). Development to adult was reduced slightly in late instars receiving an x-ray dose of 50Gy. Whereas development to adult was reduced in late instars receiving radiation dose ≥ 250 Gy. In x-ray radiation tests. When 50 late instars were treated with a target dose of 400Gy none developed as adults (Table 3). Therefore, the x-ray radiation phytosanitary treatment of a minimum dose of 400Gy for harvested litchi fruit crop effectively disinfest litchi fruits by any of these three lepidopterian fruit borers.

In general, tolerance of pupae (Fig. 3) to x-ray radiation phytosanitary treatment increased with increasing age (Table 4). No eggs were produced by surviving female when one to two day old and four to five day old pupae were treated with target doses of 150 and 250Gy. In seven to eight day old pupae, survival to adult after treatment with target doses of 150 and 250Gy was 70% and 62% respectively. In the seven to eight day old pupae group treated at 150Gy and three female were fertile where as in the 250Gy treatment only one female laid 2 eggs that were infertile. Phytosanitary treatment by x-ray radiation of adult moths affected successful reproduction (Table 5) in pre-mating radiation experiment, when both adults were treated (TM × TF) at 150Gy and 250Gy no larvae emerges. The number of females with eggs was more common in the 150Gy treatment compared to the 250 Gy treatment, and more common when the male was treated compared to when the female was treated (Table 5). No eggs hatched and eclosed from the pairings treated with 250Gy. X-ray radiation treatment of unmated adult pairs before mating or previously mated adult females, with dose of 250Gy resulted in no viable eggs after treatment. No eggs larvae of *Platypepla illepida*

Table 2. Effects of x-ray radiation on mutation of 3 days old eggs of *P. illepida*

Target dose (Gy)	Total No. of eggs	No. of hatched eggs	No. of pupae	No. of adults
0	50	42	35	17
100	50	33	24	11
200	50	25	13	8
250	50	12	3	0
400	50	2	0	0

Table 3. Effects of x-ray radiation on mutation of larvae of *P. illepida*

Instar	No. of total larvae	Targeted dose (GY)	No. of pupae	No. of adults
L 1	50	100	32	27
	50	150	25	10
	50	250	8	1
	50	400	0	0
L 23/	50	100	29	20
	50	150	22	12
	50	250	18	2
	50	400	0	0
L 4/5	50	100	35	28
	50	150	31	15
	50	250	23	8
	50	400	0	0
L 4/5 confirmaty test	50	400	0	0

Table 4. Effects of x-ray radiation on maturation of pupa of *P. illepida*

Age	No. of pupae	Target dose (Gy)	No. of adults	No. of reproduction females
1-2 days	50	0	36	21
	50	150	17	0
	50	250	4	0
4-5 days	50	0	32	12
	50	150	12	0
	50	250	3	0
7-8 days	50	0	44	10
	50	150	35	3
	50	250	31	1

Table 5. Fitness of *P. illepida* when both parents, one parent or neither parent receive x-ray phytosanitary treatment

Dose Gy/pairing	No. of pairs	Mating pairs	No. of female with eggs	No. of emerging larvae
0	50	UM × UF	49	43
100	50	UM × TF	47	13
	50	TM × UF	42	5
	50	TM × TF	36	0
150	50	UM × TF	44	3
	50	TM × UF	36	9
	50	TM × TF	31	0
250	50	UM × TF	40	0
	50	TM × UF	35	0
	50	TM × TF	20	0

T = treated, U = Untreated, F = Female, M = Male. Some pairing resulting no eggs.

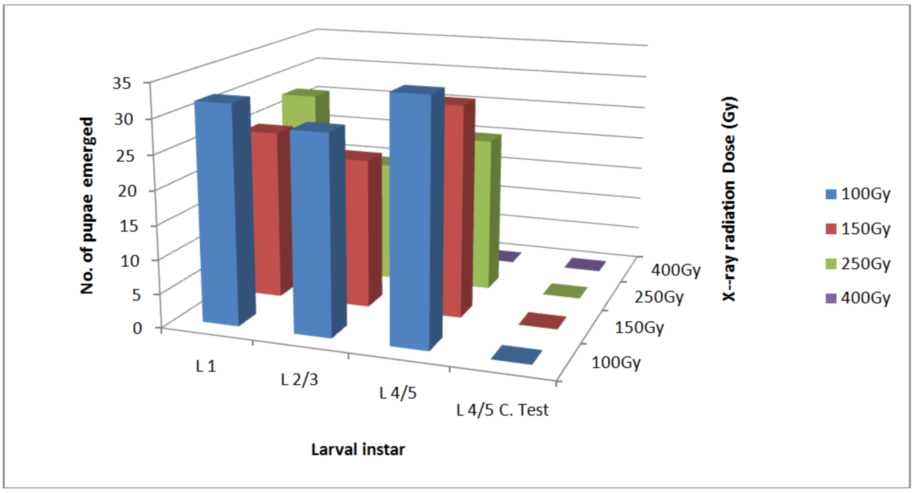

Figure 4. Graphical persentation of larvae of different instars developed as pupae after x-ray radiation dose (Gy)

receiving radiation dose ≥ 250 Gy emerged as adults and produced eggs. In the complete observation related to this study eggs, larvae, pupae and adult of *Platypepla illepida* indicating sterility can be achieved to doses well below 400Gy.

Conclusion

Litchi fruit borers of the order lepidoptera are considered the most important insect pests infesting litchi fruit crop world wide. Post harvested phytosanitary treatments are often required to completely control insect pests before the harvested litchi fruits are move in marketing channels. Several methods have been suggested to control insect pests in harvested litchi fruit crop management including pesticides, insecticides, chemical fumigation, cold storage. Present study do not involve to use of toxic chemicals which is neither consumer friendly nor environmental friendly. Based on the results of phytosanitary treatment disinfestation studies, it is considered as safe method of harvested litchi crop management. The study conducted on litchi fruit infestation by three lepidopterian insects *Platypepla illepida, Platypepla ombordelta* and *Conompomorpha sinesis* shows that x-ray radiation doses under phytosanitary treatment have the potential for disinfecting the harvested litchi fruits and *Platypepla illepida* is the more tolerant of phytosanitary treatment by x-ray than the *Platypepla ombordelta* and *Conomporpha sinensis*. If the phytosanitary treatment by x-ray radiation is made economical. It may serve as a safe and effective alternate method of most lepidopterian insects infestation control for litchi fruit crop. To achieve a balance between complete radiation of these three lepidopterian insects and maintain the litchi fruit quality, further research needs to be done on large scale tests with infested litchi fruits and provide an acceptable doses for disinfestation. This study can help in fruit borers control strategies and may help in economical benefits of market channels. Those who are involved in harvested litchi fruit crop marketing, phytosanitary treatment allowed the rise of an entire new area of the study of insects. Even today, the sterilizing insects by phytosanitary treatment can protect harticultural markets and economical benefits of litchi cultivars.

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