Annals of the Sri Lanka Department of Agriculture, 2002. 4: 269-274

STUDIES ON FRUIT FLY INFESTATION IN BANANA CULTIVARS IN SRI LANKA

H.M.R.K. EKANAYAKE
National Plant Quarantine Service, Katunayake

W.W.M.S.N. WEKADAPOLA
Faculty of Agriculture, University of Peradeniya
and
K.A.N.P. BANDARA
Horticultural Crop Research and Development Institute, Gannoruwa, Peradeniya

ABSTRACT

***Bactrocera dorsalis* (Hendel), *B. kandiensis* (Drew and Hancock), *B. correcta* (Bezzi) and *B. tau* are species of fruit flies that cause substantial economic damage to local fruits. During the latter part of 1998 and the first quarter of 1999 severe infestations of fruit flies in ripe banana were observed in some parts of the country. Investigations were carried out to identify species of fruit flies responsible for these infestations and to determine susceptibility of different banana cuitivars to fruit fly. The most susceptible maturity stage of fruits to fruit fly attack and the effect of Clorox(R) (NaOCl) on egg hatchability on banana fruits were also determined. Banana fruits collected from 20 locations from Kandy, Matale and Kegalle districts found to be infested with *B. kandiensis* and *B. dorsalis* of which the former species was more prevalent than *B. dorsalis*. Almost all cultivars of banana (Sinhalese: *Embul, Alu Kehel, Anamalu, Embun, Rathambala* and *Sini*) were susceptible to the fruit fly. Both fruit fly species did not infest immature stages (>55 d old) of banana fruits while mature green stage (70 – 75 d old) fruits were slightly attacked. Fruits more than 90-d old showed significantly higher infestations than green bananas (< 75-d old). Among ripe banana fruits that were 90 – 95-d old were more attractive to fruit flies than fruits that were 100 – 105-d old. Four concentrations of Clorox(R) (NaOCl) tested significantly reduced the egg hatchability of fruit flies but resulted in skin damage on fruits. Therefore, Chlorox(R) as a dipping treatment for infested banana fruits to prevent egg hatching of fruit flies should not be recommended.**

KEY WORDS: Fruit Fly Damage, *Bactrocera* sp., Banana Fruits, Susceptibility

INTRODUCTION

The total extent of land under fruit cultivation in Sri Lanka is about 90,000 ha and about 50 different fruit crops are grown. Banana is the main fruit crop grown throughout the country under different cropping systems. The total fruit production of the country in 1999 was about 640,000 t of which banana constituted 46%. Annual per capita fruit consumption in Sri Lanka ranges from 2.8 kg to 21.8 kg and banana contributes to a large portion of that (DOA, 1998).

Banana thrips, *Chaetanaphothrips signipennis* (Bagnal), is the only pest recorded on young banana fruits in Sri Lanka and it is considered a minor pest. Several incidences of fruit fly attacks in over-ripe bananas were reported in the past (DOA, 1998). However, several complaints were made by sellers and consumers regarding severe infestations of fruit flies in ripe banana during the latter part of 1998 and first quarter of 1999. Out of 30 species of fruit flies recorded in Sri Lanka (Tsuruta *et al.*, 1999) two species, namely *B. dorsalis* (Hendel), *B. kandiensis* (Drew and Hancock) are the most important pests of

most fruits in the country. Other potential species are *Dacus discophorus* (Hering), *D. cliatus* (Loew), *B. caryeae* (Kapoor), *B. correcta* (Bezzi), *B. latifrons* (Hendel), *B. verbascifoliae* (Drew and Habcock), *B. zonata* (Saunders), *B. diversa* (Coquillett), *B. trilineata* (Hardy), *B. caudata* (Fabricius), *B. versicolor* (Bezzi) and *Bactrocera* species near *tau*. Though the infestation of fruit flies has become a major problem in banana fruits, only a few studies has been performed. Therefore, investigations were carried out to identify fruit fly species responsible for the attack, the susceptibility of different banana cultivars and different maturity stages to fruit flies. The effect of Clorox$^{(R)}$ (NaOCl) on egg hatchability of fruit flies on banana fruits was also investigated.

MATERIALS AND METHODS

Identification of fruit fly species damaging banana and susceptibility of different banana cultivars to the pest

Samples of about 1-2 kg of fruits of different cultivars of banana were collected from 20 different locations (fruit collecting centres, stores, wholesale markets and retail stalls) in Kandy, Kegalle and Matale districts. Samples were kept separately in "Mylar film" cages with a layer of soil at the bottom in the laboratory until the emergence of adult fruit flies. The number of emerged adults was counted and identified by morphological characters.

Determination of susceptibility of different maturity stages of banana to fruit fly infestation

Fruits of five different maturity stages (groups) of the cultivars *'Embul'* obtained from an uninfected field at Gannoruwa were used in this study. The different maturity stages were: immature (25- 30-d old), immature (50- 55-d old), mature green (70- 75-d old), more yellow (90- 95-d old) and all yellow (100- 105-d old). Five selected fruits from each stage were arranged in a completely randomised design in a cage (0.3 X 0.3 X 0.9 m) and equal number of even aged males (8-d) and females (10-d) fruit flies of *B. dorsalis* and *B. kandiensiss* were introduced separately into cages. Another cage similarly arranged with banana fruits was kept free of fruit flies as the control treatment.

Twenty-four hours later, adult fruit flies were removed and the different samples were placed separately in 'Mylar film' cages until the emergence of adults. The total number of flies emerged from each sample was recorded. Data were subjected to the analysis of variance and treatments means were compared with Duncan's Multiple Range Test at $p \leq 0.05$ level.

Effect of Clorox $^{(R)}$ (NaOCl) on egg hatchability of fruit flies

Banana fruits of 90 days maturity of *'Embul'* cultivars were placed randomly in a rearing cage (0.3 X 0.3 X 0.6 m) with *B. kandiensis* for 24 hours for oviposition. Then fruit samples (five each) were dipped separately

in a series of concentrations of Clorox (R) (1, 1.5, 2 and 3%) and left for larval emergence. Number of larvae emerged from different samples were counted after peeling and slicing the fruits. Number of larvae emerged from fruits exposed to different treatments was counted. Data were subjected to the analysis of variance and treatments means were compared with Duncan's Multiple Range Test at $p \leq 0.05$ level.

RESULTS AND DISCUSSION

Fruit fly species damaging banana cultivars

Only two species of fruit flies emerged from all the samples collected in this study. They were identified as *B. dorsalis* and *B. kandiensis* of which *B. kandiensis* was common (Table 1). Only one sample of `*Embul*` collected from Kegalle district was infested by *B. dorsalis.* All the other samples collected from 19 locations in the districts of Kandy, Matale and Kegalle were infested with *B. kandiensis.*

Table 1. Fruit fly species emerged from different banana samples

Place of Collection	*Place of Origin*	*Cultivars*	*Emerged Fruit Fly Species*
Kandy District			
Akurana	Akurana	*'Embul'*	*B. kandiensis*
Alawathugoda	Alawathugoda	*'Embun'*	*B. kandiensis*
Alawathugoda	Nalanda	*'Embun'*	*B. kandiensis*
Alawathugoda	Naula	*'Embul'*	*B. kandiensis*
Gannoruwa	Gannoruwa	*'Embun'*	*B. kandiensis*
Kandy market	Rambukkana	*'Rathambala'*	*B. kandiensis*
Kandy market	Dambulla	*'Alu Kehel'*	*B. kandiensis*
Kegalle District			
Alawwa fair	Ambepussa	*'Embul'*	*B. kandiensis*
Kegalle fair	Kegalle	*'Embul'*	*B. dorsalis*
Kegalle fair	Kegalle	*'Anamalu'*	*B. kandiensis*
Mawanella	Anwarama	*'Embul'*	*B. kandiensis*
Mawanella	Anwarama	*'Embun'*	*B. kandiensis*
Mawanella	Anwarama	*'Rathambala'*	*B. kandiensis*
Mawanella	Anwarama	*'Sini Kehel'*	*B. kandiensis*
Mawanella	Anwarama	*'Anamalu'*	*B. kandiensis*
Matale District			
Matale town	Dambulla	*'Rathambala'*	*B. kandiensis*
	Galewela	*'Embun'*	*B. kandiensis*
	Galewela	*'Alu Kehel'*	*B. kandiensis*
	Matale	*'Anamalu'*	*B. kandiensis*
	Yatawatte	*'Rathambala'*	*B. kandiensis*

The two species of fruit flies were identified using morphological characters. According to the results, almost all the tested hybrids were susceptible to fruit fly attack. In Sri Lanka, domestic market involves multi-channelled distribution of banana. In each stage of distribution, banana fruits remain in one place for some time before getting into the next stage. This lagging period is sufficient enough to the get fruit fly infestation. During the

year 1999, the average maximum and minimum ambient temperatures were between 25- 31^0 C and 19- 22^0 C respectively. Temperature plays a major role in increasing fruit fly population. The most active temperature range for the development, reproduction and survival of fruit flies is 25- 30^0 C and flies became inactive below 20^0 C (Narayan and Batra, 1960). In this temperature range, if host fruits are available, fruit flies produce many overlapping generations and ultimately resulted high fruit fly populations (Allwood, 1996).

According to weather records, considerable amount of bright sunlight has been received throughout the year 1999 (DOA, 1999). Therefore, the light factor and the scattered rain pattern of the year have provided optimal moisture conditions to build up the fruit fly population during this period.

Susceptibility of different maturity stages of banana to fruit fly infestation

No infestations of any species of fruit flies were observed in immature stages of banana (<55-d old). A slight infestation was observed in mature green stage (70- 74-d old). More yellow and all yellow stages (>90-d old) showed significantly higher infestation (P≤ 0.05) when compared with immature and mature green stages (Table 2). Mean number of adult emergence of *B. kandiensis* was higher than *B. dorsalis*. These results indicate that the banana fruits get fruit fly infestations only after ripening.

Table 2. Mean number of fruit fly adults emerged from infested banana fruits

Maturity Stage	*Mean Number of Adults Emerged/5 Fruits*	
(d)	*B. dorsalis*	*B. kandiensis*
All yellow (100 – 105)	2.75 ab	7.00 ab
More yellow (90 - 95)	4.00 a	10.75 a
Mature green (70 – 75)	1.25 bc	0.75 b
Immature (50 – 55)	0.00 c	0.00 b
Immature (25 – 30)	0.00 c	0.00 b

Means followed by the same letter are not significantly different at (p≤ 0.05) according to DMRT

Several changes take place simultaneously during the ripening of banana fruits. Tissue softening commences as starch is degraded to sugars in both pulp and peel (Robinson, 1996). These factors turn the peel of fruit to light green then to yellow as chlorophyll breaks down. Along with these changes, a characteristic aroma is produced due to acetates, alcohol and carbonyl compounds produced along the metabolic pathways. Phenolic compounds (e.g. dopamine) that make the fruit resistant to infestations are reduced with ripening. Volatile components of ripening fruits stimulate and guide/attract adult fruit flies to the host (David, 1991).

The composition of immature and unripe fruits may not be favourable for the development of fruit fly larvae. The changes that occur during the ripening process may attract fruit flies and provide favourable media for their

larval development. Therefore, the possibility of fruit fly infestation in immature banana under field conditions is very rare. The recommended harvesting time of banana is about 80 days after flowering. If bananas are harvested at the correct harvesting stage, field infestation of fruit flies can be minimized.

However, during distribution and displaying fruits at sales outlets, the ripe bananas can easily get infested with fruit flies. The final stage of the distribution process can be considered as the main infestation stage. Within a few days (1 - 4) of this displaying stage, fruit flies lay eggs on fruits and larvae emerge. These larvae can be seen in ripe banana fruits. Hence, prevention of banana fruits being exposed to adult female fruit flies in sales outlets should be promoted with plastic mesh covers.

Effect of Clorox(R) on egg hatchability of fruit-flies

Fruits in two treatments namely the control treatment and treatment with 1% concentration of Clorox (R) showed significantly higher larval emergence of 31 and 26 respectively while fruits dipped in concentrations 1.5% and 2% showed similar pattern of egg hatchability (larval emergence). The lowest larval emergence was recorded in 3% concentration of Clorox (R) (Table 3).

Table 3. Mean number of larvae emerged from banana fruits treated with different concentrations of Clorox (R)

Clorox (R) Concentration (%)	*Mean Number of Larvae Emerged/ Fruit*
Control	31.0 a
1.0	26.0 ab
1.5	23.7 b
2 .0	22.0 b
3.0	14.7 c
CV	16.6

The means followed by the same letter are not significantly different (p≥ 0.05) according to DMRT

These results indicate that the egg hatchability of fruit flies decreases with increasing concentrations of Clorox(R). Sodium hypochlorite, the main chemical constitute of Clorox(R) is capable of dissolving egg cases of fruit flies. However, the egg hatchability of infested banana fruits cannot be totally controlled by Chlorox(R). Higher concentrations of Chlorox(R) (especially with >1.5%) affected the skin of banana. These burning patches on ripe banana affect the fruit quality. Dipping bananas in a solution of 100 ppm of Chlorox(R) has been used as a post harvest treatment to control fungal and bacterial diseases of mature banana fruits (DOA, 1980 - 1995). However, dipping fruit fly infested banana in higher concentrations of Chlorox(R) to control fruit fly infestation can not be recommended.

CONCLUSION

B. kandiensis and B. dorsalis were responsible for infestation of banana fruits in Kandy, Kegalle and Matale districts. *B. kandiensis* is more prevalent than *B. dorsalis* in locations sampled. Almost all the tested banana cultivars *(Embul, Alu Kehel, Anamalu, Ambun, Rathambala* and *Sini Kehel)* found susceptible to the pest.

Both *B. kandiensis* and *B. dorsalis* did not attack immature stages of *Embul.* Mature green stage (70- 75-d old) is subjected to mild attack. More yellow (90- 95-d old) and all yellow (100- 105-d old) stages of banana fruits are severely damaged but fruit flies are more attracted to all yellow stage (90- 95-d old) of banana fruits. Egg hatchability of fruit flies is inversely proportionate to the concentration of Clorox $^{(R)}$. Higher concentrations reduce the egg hatchability but it cannot be totally controlled even with higher concentrations of Chlorox$^{(R)}$. As skin of the banana fruit gets burnt with higher concentrations of Chlorox$^{(R)}$ especially at 2% and 3%, dip treatment can not be recommended to prevent the egg hatchability of fruit flies in infested banana fruits. Hence, banana should be harvested at green maturity stage (80- 85-d old) and prevention of fruits coming in to contact with adult female fruit flies in sales outlets should be promoted with plastic mesh covers.

ACKNOWLEDGEMENTS

Technical assistance given by Mr. Kasthuri Weerasuriya during the course of this study is gratefully acknowledged.

REFERENCES

Allwood, A.J. 1996. Prerequisite for understanding and managing fruit flies (Diptera: Tephritidae) In: Management of fruit flies in the Pacific. Allwood, A.J. and Drew, R.A.I.,(Eds)., Australian Centre for International Agriculture research GPO Box 1571, Canberra, Brown, Prior and Anderson, Melbourne. 95-100.

David, D. 1991. Insect pest management, Redwood books, Trowbridge, Wiltshire, U.K.

DOA. 1980 – 1995 and 1998. Research Reports, Horticultural Crops Research and Development Institute, Department of Agriculture, Peradeniya, Sri Lanka.

DOA. 1999. Weather Reports, Natural Recourses Management Centre, Department of Agriculture, Peradeniya, Sri Lanka.

Narayan, E.S. and H.N. Batra. 1960. Fruit flies and their control. Norman A Ellis (Ed).Baptist Mission Press 41 a Lower Circular Road, Calcutta. 49-66.

Robinson, J.C. 1996. Bananas and Plantains. University Press, Cambridge. 216p.

Tsuruta, K., G.B.J.P. Rajapakse and T. Kawashita. 1999. Pictorial key to fruit flies of tribe Dacini (Diptera: Tephritidae) of Sri Lanka. National Plant Quarantine services Project (JICA), Katunayake, Sri Lanka.