Current Status of the Solanaceous Fruit Fly Control Project in Yonaguni Island

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Abstract

The solanaceous fruit fly, *Bactrocera latifrons* (Hendel) was first discovered in 1984 at Yonaguni Island, and then disappeared after 1986. However, in 1999, it re-invaded the island, and has since established in the area until now. *B. latifrons* has been found only in Yonaguni Island, and eradication must be done urgently before its expansion to other areas in Japan. To prevent the spread of this species from Yonaguni island which is located in the western-most part of the country, to other islands, we have not only been studying the biology and ecology of this species, but also conducting protein bait spray and other control measures. Furthermore, we are implementing research and development initiatives to control the fruit fly by using the sterile insect technique (SIT), which includes mass rearing, sterilization, transportation, and releasing method, parallel with a population census of this species in the field. This paper reports our attempt to implement an area-wide control for solanaceous fruit fly.

Key words: *Bactrocera latifrons*, protein bait spray, SIT

1. Introduction

The solanaceous fruit fly, *Bactrocera latifrons* (Hendel), was discovered for the first time in the Yonaguni Island in 1984 (Teruya 1994). The establishment of this fruit fly has not been confirmed in regular fruit surveys until October 1999, and was found to have existed in the island until the following year. Until now, its continuous occurrences have been found after discovery of the larvae in 1999.

Therefore, it is believed to have completely established in the Yonaguni Island.

This species is distributed from India to Southeast Asia, China, and Taiwan, and was discovered for the first time in Oahu island of Hawaii in 1983 (Vargas and Nishida 1985). Its distribution then expanded to Hawaii island and Maui island (Liquido et al. 1994). *B. latifrons* is an economically important insect pest that has caused serious damage to solanaceous crops such as chili pepper, tomato, and eggplant (Vijaysegran and Osman 1991, Liquido et al. 1994).

There is fear that the distribution of the species could expand to Yaeyama islands, and to the whole area of Okinawa Prefecture by bringing in host fruits and/or by the movement of adult flies. Moreover, because it might be infesting not only solanaceous crops but also cucurbitaceous crops (Liquido et al. 1994), it is necessary to urgently conduct control measures before its distribution expands from the Yonaguni Island to the other islands.

Effective control method of this species has not been established yet. Moreover, there is no effective attractant available for use in monitoring of fruit flies (Mcquate and Peck 2001). Currently, we have been conducting an area-wide control with protein bait application, and have been carrying out research and development on sterile insect technique (SIT) to prevent the spread of this species to other regions.

This paper outlines the current status of and the area-wide control project for solanaceous fruit fly in the Yonaguni Island.

2. Yonaguni Island

Yonaguni is an island with a total area of 2,888 ha located in the western-most part of Japan (Fig. 1). The distance between this island and Taiwan is about 110 km.

3. Periodical Surveys

3.1 Survey of host fruits

Solanaceous fruits and wild cucurbitaceous fruits were collected from the whole island once a month, and the presence of infestation was investigated. The collected fruits were kept for 2-3 weeks (25^{o}C), then checked for the number of pupae. These pupae were kept in vermiculite for 2 weeks (25^{o}C), then the flies that emerged were identified.

3.2 Yellow sticky trap survey

Pieces of yellow adhesive tapes were placed in cylindrical plastic containers to form yellow sticky traps (Fig. 2). Thirty (30) yellow sticky traps were set up in the region in the Yonaguni island where the solanaceous fruit fly was first discovered and is still established until now, then these were investigated twice a month.

3.3 Control

Protein bait application

Protein bait treatment (5 liters of protein autolysate + 500 g of insecticide per 1,000 liters) was conducted by using speed sprayer in 2004 and 2005. We applied protein bait treatments three times at 10 days interval. This treatment was replicated three times a year. The infested area was pinpointed based on information from previous host plant survey, and the protein bait spray was applied for bushes in the local area. Furthermore, we carried out intensive spot spraying of protein bait of the infested host plants by using hand sprayer. In this case, more dense protein bait (0.5 liters of protein autolysate + 25 g of insecticide per 20 liters) was used.

Removal of host plant

Removal of wild host plants was carried out 2-3 times a year in the residential area.

Sterile insect technique (SIT)

Solanaceous fruit fly is an invasive species and the threat of its expansion to other regions causes some alarm. Therefore, sterile insect technique (SIT) is intended as a control method to completely eradicate

this pest. Research and development on SIT is now ongoing. Researches have been done on mass-rearing and sterilization. Details about SIT are not included in this report.

Public relations

The voluntary transportation regulation of host fruits is now being promoted in the area. Local farmers were asked not to transport solanaceous fruits produced in Yonaguni outside of the island, through information campaigns such as the distribution of leaflets and holding of briefings.

Monitoring trap with attractant

Although an investigation of a-Ionol with Cade oil, a known solanaceous fruit fly attractant (Mcquate and Peck 2001, Mcquate et al. 2004), has been done, capturing wild flies using attractants is highly difficult. This may probably be due to the low density of solanaceous fruit fly in the field of Yonaguni Island. Therefore, attractant was not used for the monitoring.

4. Results and Discussion

4.1 Host survey

In 2004, 55,586 fruits were collected from a total of 401 points, and infestation by the species was confirmed in 21 points (5.2%) among all the points surveyed (Table 1). In 2005, we collected 86,180 fruits from 288 points, and infestations were found in 19 points (6.6%).

Infestations were found in *Solanum nigrum*, *Solanum photeinocarpum* of a wild plant, and *Solanum melongena* and *Lycopersicon esculentum* of the cultivated crops in solanaceous family.

In addition, though the infestation of this species has been confirmed only in solanaceous fruits by conventional host plant survey, many of this species were discovered in other spots in the fruits of *Diplocyclos palmatus* of

cucurbit family in an investigation conducted in July 2004, when there were few Solanum fruits. This result showed the possibility that cucurbit fruit is an important potential host.

The damage to cucurbit fruits with possible distribution expansion is consistent with what has been reported previously in Hawaii (Liquido et al. 1994) . For red peppers, infestation has already been confirmed in Southeast Asia (Vijaysegran and Osman 1991), and in plant quarantine reports in imported fruits from Asia (Anonymous 2005). However, the damage to red pepper by this species in Yonaguni Island has not been confirmed yet until now in Yonaguni Island. The cause is also unknown.

Solanaceous fruit fly was found in many places in Yonaguni Island, but infestation rate was not so high and tended to be distributed widely when the infestations were plotted on the map (Fig. 3). Therefore, it is believed that the pest can be effectively controlled with the intensive use of protein bait spray.

4.2 Yellow sticky trap survey

In an investigation using yellow sticky traps in 2005, only six solanaceous fruit flies were detected. The traps seemed to be not effective as a means of monitoring the general population trend. However, although infestation was not confirmed by conventional host fruit survey in 2006, one *B. latifrons* fly was detected from the yellow sticky trap survey in June 2006. This suggests that yellow sticky traps may be used for population dynamics investigation of the species in confirmed host plant community of infestation until an effective attractant is discovered.

4.3 Control effects

In the host plant survey, infestations decreased after the initiation of protein bait application in 2004, and there has been no infestation since August 2005. However, there is a possibility that this species maintains a low density population, so that further investigation is needed in order to implement effective control measures.

4.4 Sterile insect technique

The eradication control of solanaceous fruit fly while outbreak is low in Yonaguni Island is believed to be a wise policy decision from the long-term point of view. A strong attractant for *B. latifrons* has not been discovered yet, and the male annihilation technique, which has been used in oriental fruit fly eradication campaign (Koyama et al. 1984), cannot be used in this case. Therefore, we decided to adopt the sterile insect technique (SIT) which is the most ecologically sound pest control method for eradication and can be used in different countries in the world (Hendrichs 2000). We have a plan to finally aim at eradication of *B. latifrons* in Yonaguni Island by SIT, while continuing the removal of host plants and the protein bait treatment to keep this species at low population density.

There were many studies of mass rearing of *B. latifrons* (Vargas and Michell 1987, Vargas et al. 1990, Vargas et al. 1993). Referring to these researches, and having introduced some improvements, increases in egg yield and the recovery rate from egg to pupae have been achieved. In addition, the decision on the appropriate irradiation dose for this species for sterility was made (Srikachar et al., unpublished). Further research and development such as the transportation of pupae, sterile fly release method, and control efficacy method are necessary for the successful adoption of SIT.

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5. References

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Table 1 Summary of fruit survey on Yonaguni island in 2004

Host plant	Locations	infested locations	No. of fruits collected	No. of emerged flies
Solanum nigrum	**11**	**4**	**2,472**	**28**
Solanum photeinocarpum	**102**	**6**	**30,943**	**17**
Physalis minima	3	0	148	0
Physalis angulata	1	0	26	0
Capsicum annuum	17	0	831	0
Capsicum sp.	3	0	23	0
Capsicum frutescens	20	0	1,059	0
Lycopersicon esculentum	**20**	**3**	**1,032**	**28**
Solanum melongena	**15**	**2**	**108**	**14**
Solanum ciliatum	1	0	6	0
Solanum erianthum	1	0	12	0
Diplocyclos palmatus	**87**	**6**	**15,285**	**26**
Zehneria liukiuensis	1	0	52	0
Other cucurbit	35	0	253	0
Other fruits	84	0	3,336	0
Total	401	21	55,586	113

Fig. 1 The location of Yonaguni Island.

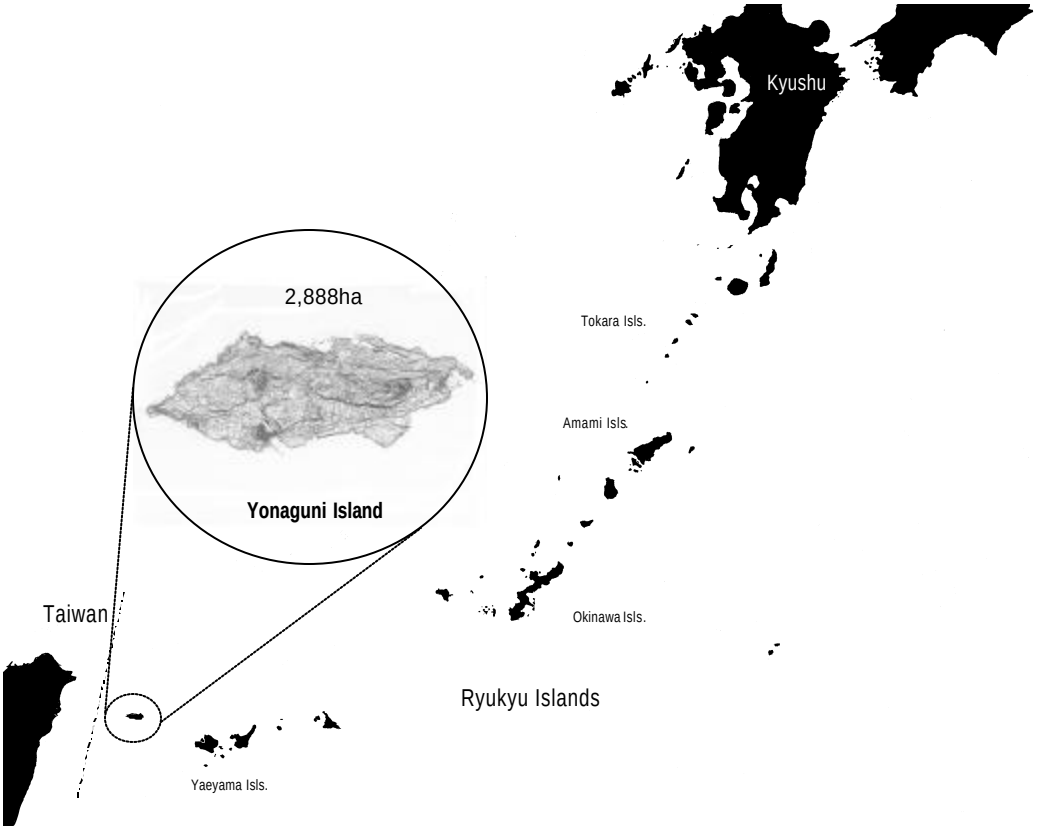

Fig. 2 The yellow sticky trap.

Fig. 3 The points of fruit collection in the 2004 survey. Green circles indicate points with infestation, while red circles indicate no infestation.