

Report of the APPPC Training Workshop on Fruit Fly Management

20-25 June 2016

Tien Giang Province, Viet Nam

Summary

Tephritid fruit flies (Bactrocera dorsalis & Bactrocera cucurbitae) are important insect pests, which are closely linked with food security and food safety in many Asia countries. It *causes direct damage to fruits and vegetables leading to 90-100% yield losses*. The infestations result in serious losses in trade value due to restrictions on market access and the compliance costs of phytosanitary measures for fresh fruit exported from countries with major fruit fly infestations. Meanwhile, the overuse of chemical pesticides resulted in potential risk to producers and consumers, as well as the environment and affect the export of the fruits of Viet Nam to other countries. Therefore APPPC Training Workshop on Fruit Fly Management was adopted as one of work plans by APPPC Standing Committee on IPM.

The training workshop was hosted by Viet Nam Plant Protection Department from 20-25 June 2016 in Tien Giang, Viet Nam with participation of 24 delegates from 14 countries, this included FAO technical officers. The workshop aims to provide an opportunity to improve capacity of participating countries in fruit fly management based on ecological approach.

The training workshop enabled participants to improve knowledge and skills of area-wide fruit fly management with ecological approaches. It benefited participants by improving their capacity in identification of several important fruit fly species by focusing on similarities and distinguish among species; enhanced knowledge of fruit fly management strategy especially 1-2-3 strategy, which includes use of protein baits, orchard sanitation and fruit fly monitoring by using traps (lures); learned how to organize fruit fly management farmer field schools (FFS) including arrangements of pre/post FFS in details, main context of the FFS as well as skills of communication with growers.

In addition, participants could share experience in fruit fly managements. Participants from China, Nepal, Pakistan and Philippines briefed other participants with their update status of fruit fly infestation and managements. Regional IPM programme highlighted pilot experiences of area-wide promotion and adoption of FF IPM-FFS in lower Mekong river basin countries (2010-2015) based on a former regional project (AIT/FAO).

Furthermore the workshop facilitated interactions among participants from IPM section and quarantine section as well as academic institute. It helped participants to enrich knowledge from field practice to exporting markets access requirements. Meanwhile delegates explored potential networking of collaboration in fruit fly managements.

The workshop was characterized with ownership of APPPC member, it has been reflected in the preparation, facilitation and participation of the workshop. Viet Nam PPD played key roles in organizing the workshop in collaboration with FAO and other member countries. This is a new trend of APPPC in the past 3 years. In addition, it was very participatory training workshop with active interaction among participants with hand-on exercises either in fruit orchards or in-door as well as group discussions.

It is hoped that all participants would act as master trainers in their own countries to enhance the capacity development in fruit fly management to contribute to the country food security and exporting market access capabilities. Meanwhile it is expected that all participants might be able to networking in the region for fruit fly management to share information on status and update development of fruit fly management, resources of expertise in identification as well as SOPs, etc.

Report

I. Detailed Activities' Results

1. Opening ceremony

The APPPC training workshop on Fruit Fly Management was officially opened after Dr. Nguyen Quy Duong, Deputy Director General Plant Protection Department (PPD), provided a warm welcome to all participants and facilitators from 14 countries. As an attempt to support developing countries in Asia-Pacific region, FAO has initiated various projects and activities in training trainers, training farmers and developing training curricular. Dr. Piao Yongfan, FAO Regional office for Asia and the Pacific gave an update on IPM activities and explained that the training workshop on fruit fly management was a very good opportunity for technical staff/IPM trainer responsible for management of plant pests GMS countries to upgrade their skills and knowledge to control/manage fruit fly. Dr. Nguyen Quy Duong, Deputy Director General (PPD) graced the Opening Ceremony and thanked FAO/APPPC for selecting PPD as the host for the training workshop on fruit fly management.

Ballot box test (Pre and Post)

In the training workshop on fruit fly management, participants' knowledge and skills were evaluated before and after the training by using the ballot box test. There were 20 ballot boxes used for the test; one question per ballot box. The results of ballot box test are presented as part of this report in **Annex 4**.

2. Overview of fruit flies species in Asia

The Asian region (East, Southeast and South) is among the top three regions worldwide for both exporters and importers of fruits. Among the various sub-regions in Asia, the Mekong river basin countries are major producers of a range of economically-important fruits for domestic consumption, regional and international trade. However, several factors constrain fruit production such as Tephritidae fruit flies *Bactrocera dorsalis* (*B. dorsalis*) and *Bactrocera cucurbitae* (*B. Cucurbitae*) and possibly others like *B. correcta*). These fruit flies (FF) cause direct damage to fruits which can lead up to 90-100% yield loss depending on fruit fly population, locality, variety and season. In addition, to the direct losses, fruit fly infestation can result in serious losses in trade value and export opportunity due to strict quarantine regulations imposed by most importing countries.

The tephritid genus of fruit flies, with more than 500 species currently described constitutes important pests of reproductive stages of a number of fruits in Asian countries. A number of economically important and widely prevalent species of this genus such as *B. dorsalis* (Oriental Fruit Fly, OFF), *B. correcta* (Guava fruit fly, GFF), *B. papayae* (Asian papaya fruit fly), *B. carambolae* (Star fruit fly) are commonly found in SE and South Asia. *B. dorsalis* is one of the most common species and it is similar to the closely related species *B. carambolae*, *B. papayae*, *B. occipitalis*, *B. philippinensis* and *B. invadens* in color pattern and referred as a species complex.

Life cycle of fruit fly

The life cycle of fruit flies is typical of higher flies (Diptera: *Cyclorrhapha*). The female lays eggs into host fruits, and these eggs hatch to larvae (or maggots). The larvae that hatch initially are small and delicate first instar (or first stage) larvae. They moult into slightly more robust second instar larvae, and these in turn moult into quite stout and tough third instar larvae. When the third instars have finished feeding they leave the fruits, fall to the ground, and crawl away to a sheltered spot (usually in the soil) where they pupate. The larval skin becomes barrel-shaped, tanned brown and hard, and is known as the puparium. The true pupa is formed inside this puparium shell. The pupa turns into an adult fly, which escapes from the puparium by splitting open the anterior end and squeezing out. Female flies do not develop eggs for several days after emergence, and need a protein feed to be able to do this. This is why protein baits mixed with insecticide are an effective control method. Most fruit flies are facultative breeders that will lay eggs whenever their host fruits are available, and so may have many generations per year depending on host fruit availability.

Crop losses

The damage starts when the female fruit fly punctures the fruit with its long and sharp ovipositor. The fruit skin is breached, and bacteria enter and the fruit starts to decay. The larvae that hatch from the eggs feed on the decaying fruit tissue, and on the yeasts and bacteria that multiply in it. It is believed that some fruit fly females carry bacteria with them that they inject into the fruit at oviposition so that the fruit decays faster (making it more nutritious for the larvae).

Fruits with fruit fly larvae in them decay quickly. It is sometimes possible to cut out the damage for home consumption of the remaining part of the fruit, but infested fruits are generally unsalable, and can certainly not be exported. Crop losses can vary from a few per cent up to 100%. In some cases losses can be reduced by other treatments applied by the farmers in an area, e.g. against another orchard pest, or in another crop intercropped in the orchard.

Common techniques used for FF IPM

There are some IPM methods to control fruit fly as follows:

- a) ***Biological control:*** eggs and larvae are main stage. Hymenopteran parasitoids are commonly employed; biological control alone does not provide high degree of control on sustainable basis.
- b) ***Crop hygiene/sanitation:*** removal of fallen fruits/old crops; each fruit can produce up to 400 FF adults. Removal and destruction is very important for FF IPM; collected fruits should be buried 6 inches deep in soil; some part of China achieved good success in reducing population of FF using sanitation.
- c) ***Bagging/netting:*** young fruits should be completely bagged; bags must not have any holes; prevent oviposition. Initially labor intensive; increases cosmetic value of fruits; age of bagging of different fruits varies.
- d) ***Insecticides:*** Not recommended in IPM as there are other robust tools available; however in citrus fruits FF can be suppressed by a single spray; limited use of pesticides in protein baits.
- e) ***Bait sprays:*** adult FF needs protein for their reproductive functions; beer waste based protein baits or other mixed with insecticide have been successfully used in Viet Nam for past 7-8 years.

f) **Early harvesting:** Due to color preferences for oviposition, some fruits at early stage are not host, in such cases this method could be employed; e.g. green mango are not hosts of FF.

g) **Male annihilation:** using lures (ME) and cue-lures; large number of traps are needed; traps are excellent tools for ministering flies population.

3. Protein bait for controlling fruit fly

Protein baits are food substances, which attract fruit flies. Fruit flies need sugars and proteinaceous food to survive and mature. They utilize various sources such as microbes, pollen, etc. The protein sources are normally derived from plant or yeast extracts (hydrolysate yeast or autolysate yeast) and can attract both adult male and female flies from 50 meters.

4. Methyl Eugenol and Cue-lure

A very useful and rapid method of monitoring the population of pest fruit flies in an area is to use male lures or attractants. These are chemicals that have a powerful attraction to some species of adult male fruit flies. Very widely used for *Bactrocera* species are the compounds Methyl Eugenol (ME) and Cue Lure (CUE). ME attracts both male Oriental Fruit Fly (*B. dorsalis*) and male Guava Fruit Fly (*B. correcta*), while the compound Cue Lure (CUE) attracts male Melon Fly (*B. cucurbitae*). Methyl Eugenol and Cue Lure do not attract the females. Since the ratio of male: female adult fruit flies on emergence from the pupae are always about 1:1 male lures in simple and cheap traps can be used to monitor fruit fly populations in an IPM programme.

5. Field trip

All participants spent two days to observe and practice activities on fruit fly management. The participants were divided into 4 groups to make collect sample flies in the traps. And then, participants in each of the 4 groups identified the species and sex of fruit fly collected from ME traps and Cue Lure (Bitter Gourd) traps, classify the flies collected: *B. dorsalis*, *B. correcta*, *B. cucurbitae* and *B. carambolae*. Also, the group will analyse the characteristics of the samples on glass and photography as well as observe the larvae in damaged fruit and conduct microscopic observation.

II. Conclusion

The APPPC Training Workshop on Fruit Fly Management was successfully completed with a total of 24 participants and facilitators from 14 countries, this included FAO technical officers. The participants gained more knowledge and skills on how to make the fly population monitoring at the level off FFS, build the exercise sanitation field guide and baseline survey. They also understood very well how to organize FFS and community activities to manage fruit fly. During the workshop training, the participants developed the content and guidelines final report of FFS **Annex 5**.

III. Recommendations and follow up

- All participants have to bring all knowledge and skills learnt from the training workshop to conduct sessions to educate and guide farmers in managing and controlling fruit fly.
- FAO/ APPPC should organize more training workshop on IPM, fruit fly and vegetable fly management.
- FAO/ APPPC should facilitate the networking in fruit fly management in future.
- Each country should build fruit fly management programme to follow up fruit fly population at every month or crop season and how to control fruit fly.

- Participants should continuously keep contact and share successful experience in fruit fly management.

IV. Acknowledgements

Acknowledgements and thanks were addressed to:

Mr. Piao Yongfan, FAO Regional office for Asia and the Pacific;

Mr. Nguyen Quy Duong, Deputy Director General Plant Protection Department (PPD);

Mr. Le Quoc Cuong, Director of Southern Regional Plant Protection Center (PPD);

Mr. Le Quoc Dien, Director of Advanced Technical Transfer Center (ATTC) Southern Fruit Research Institute (SOFRI);

Mr. Chu Hong Chau, Vice Director of Post-Entry Plant Quarantine Centre No.2 (PPD).

and all participants who actively participated in the training workshop.

Timetable

Date	Time	Activity	
Sunday 19-6- 2016	Morning, Afternoon	▪ Arrival of participants, check in at Tien Giang Guest's house	
Monday 20-6- 2016	Morning	▪ Prepare traps and baits placed in the field in Chau Thanh district, Tien Giang province	▪ SRPPC
	Afternoon	▪ Introduce training workshop ▪ Opening ceremony by the Deputy GD – PPD – MARD ▪ Pre- test ▪ Group photo ▪ Introduction of participants ▪ Grouping of participants	▪ Piao Yongfan ▪ Nguyen Qui Duong
Tuesday 21-6- 2016	Morning	▪ Sharing activity FFS/ IPM in Viet Nam ▪ Life cycle, biology, damage and control measure current ▪ Understand of principles of apply protein bait and Methyl Eugenol and Cue-Lure ▪ Sharing activity FFS/ IPM in China	▪ Khanh ▪ Dien ▪ Dien ▪ Li Ping
	Afternoon	▪ Overview of fruit life related to food safety and export ▪ Biological control of fruit flies using <i>Beauveria bassiana</i> auto dissemination ▪ The opportunities and challenges: review of the plant quarantine on Tephritids in China	▪ Chau ▪ Hellen ▪ Zhihong Li
Wednesday 22-6- 2016	Morning	▪ Field trip to Kim Son commune, Chau Thanh district, to observe the placed baits and traps. Collect sample flies in the traps. Back to Hall at Southern Horticultural Research Institute (SOFRI) ▪ Group classify the flies collected: B.dorsalis, B.correcta and B.cucutbitae. Analysis of the characteristics of the samples on glass and photography ▪ Observe the larvae in damaged fruit and conduct microscopic observation	▪ Khanh, Chau ▪ Chau, Loc, Khanh
	Afternoon	▪ Classification of fruit flies (continue): B.dorsalis, B.correcta and B.cucutbitae.	▪ Chau, Loc, Khanh
Thursday 23-5- 2016	Morning	▪ Overview of fruit fly in Asia and the world, sustainable management practice ▪ Discuss on how to make the fly population monitoring at the level of FFS ▪ FFS institutionalization and net working in Asia ▪ Fruit flies surveillance work in citrus an experience of Nepal. Survey protocol for fruit fly	▪ Jan ▪ Dien ▪ Jan ▪ Babu Tiwari
	Afternoon	▪ Sanitary and phytosanitary (SPS) compliance and fruit fly management in export of Pakistani mangoes ▪ Develop the content of the FFS	▪ Tariq ▪ Dien, Khanh,

		<ul style="list-style-type: none"> ▪ Discuss about what to consider when organizing FFS pheromol trapping time, arrangement of IPM and FP. ▪ Monitor by trapping flies ▪ Technical placed baits kill flies, bait spraying technique ▪ Techniques wrapped fruit for each type of fruit 	Chau, Loc
Friday 24-6- 2016	Morning	<ul style="list-style-type: none"> ▪ Field trip: Observe harvest sanitation practices including field and fruit Return to the hall ▪ Group discussions: building exercises sanitation field guide 	<ul style="list-style-type: none"> ▪ Cuong, Khanh, Chau, Loc
	Afternoon	<ul style="list-style-type: none"> ▪ Groups present the results discussed, a result of field sanitation guidelines ▪ Groups develop the selection criteria of crops and site ▪ Groups develop the form of baseline survey 	<ul style="list-style-type: none"> ▪ Cuong, Khanh, Chau, Loc, Dien
Saturday 25-6- 2016	Morning	<ul style="list-style-type: none"> ▪ Discuss about building content FFS ▪ Guidelines report on the final results of the FFS ▪ Discuss the organization of community activities ▪ Discuss the action plan locally ▪ Post-test ▪ Closing of the training workshop 	<ul style="list-style-type: none"> ▪ Cuong, Khanh, Chau, Loc

Background Information on the Sites of the Field Visit

Day 1 (22nd June, 2016): Sapodilla

Sapodilla (*Manilkara zapota*) in Viet Nam is mainly grown in Chau Thanh district of Tien Giang province with total area around 1,600 ha. Six communes of Phu Phong, Kim Son, Song Thuan, Vinh Kim, Ban Long and Dong Hoa in Chau Thanh have 850 ha of cultivation area engaging 3,000 farmers. Other growing areas include Cai Rang and Binh Thuy district of Can Tho city and other provinces with smaller pockets.

- Person in charge: Mr. Vo Dong Lap, 38 years old
- Location: 100 3295950N, 1060 2463380E
- Elevation: 9 m ASL
- Address: Hoi hamlet, Kim Son commune, Chau Thanh district, Tien Giang province.
- Total area: 2 ha (150 trees 23 years old, 200 trees 13 years, 150 trees 11 years)
- Soil: Clay acidity sulfate soil, pH range 5-6.5
- Source of planting material: Long Mut variety by air layering in the farm
- Human resource: two home labors and hired 4-6 part time one
- Fertilizer: 1-2 kg organic fertilizer and 750- 1.000 g NPK/tree/month
- Harvesting manually: from September to March
- Average yield: 250-300 kg/tree (10-15 years old)
- Constraints: 1) Pest and diseases such as scale, fruit fly, fruit borer and 2) only for local markets

Day 2 (24th June, 2016): Dragon fruit

Dragon fruit or pitaya (*Hylocereus undatus*) is one of the biggest exported fruit of Viet Nam. About 80-90% of production is for export markets that includes China, Thailand, Philippines, Japan, South Korea, and Europe, The United States, New Zealand and other countries. The rest is for domestic markets that includes processing. The total production in 2013 was about 617,500 tons from cultivation area of about 28,700 ha. Dragon fruit can be harvested all year through advanced crop management techniques. The main growing areas in the country are Binh Thuan (20,270 ha), Tien Giang (4,200 ha) and Long An (5,190 ha). Out of the total production area, 3,000 ha are cultivated with red flesh dragon fruit Long Dinh No. 1 that was developed by SOFRI.

Dragon fruit at Cat Tuong Farm

- Person in charge: Mr. Doan Van Sang, 40 years old
- Location: 100 23.7750N, 1060 16.9400E
- Elevation: 9 m ASL
- Address: No. 1 hamlet, Thanh Tan commune, Tan Phuoc district, Tien Giang province.
- Total area: 25 ha with 4 years old trees
- Soil: Clay acidity sulfate soil, pH range 3-4 during dry season and 4.5-5.5 during raining season
- Source of planting material: Red flesh dragon fruit Long Dinh No. 1 of SOFRI
- Human resource: four regular staffs for management and 200 seasonal labour staffs depending on need

- Organic fertilizer include chicken manure, coconut husk, rice straw has been applied two times a year at 5 kg/tree/each application, chemical fertilizer include DAP and NPK at 100g/pole/time, for 4 times/season
- Harvesting at 28-30 days after fruit setting
- Average yield: 30 ton/ha/year
- Constraints:1) Pest and diseases such as fruit soft rot, beetle, ant and 2) rarely for local markets
- Input cost: 15-20%
- Income: 400 million VND (20.000 \$)/year/ha

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Result of Pre- and Post-test

No.	Name	Country	Pretest result	Post test result	Increase
			Percentage (%)	Percentage (%)	Percentage (%)
1	Phoukaothong Sykaisone	Lao PDR	93.75	93.75	0
2	Dinesh Babu Tiwari	Nepal	62.50	68.75	6.25
3	Huynh Thanh Loc	Vietnam	68.75	100.00	31.25
4	Le Thi Dieu Xuan	Vietnam	68.75	87.50	18.75
5	S.M. Ashraf Ali	Bangladesh	62.50	62.50	0
6	Helen Gallego Bignayan	Philippines	68.75	75.00	6.25
7	Herti Endang Rosmayani	Indonesia	68.75	87.50	18.75
8	Chea HO	Cambodia	50.00	75.00	25.00
9	Rosmaiza binti Muhamad	Malaysia	43.75	68.75	25.00
10	S.S. Weligamage	Sri Lanka	68.75	75.00	6.25
11	Shine Shane Naing	Myanmar	75.00	87.50	12.5
12	Sunyanee Srikachar	Thailand	87.50	100.00	12.5
13	Watchreeporn Orankanok	Thailand	75.00	93.75	18.75
14	Yun-Mo KOO	R. Korea	50.00	68.75	18.75
15	Deuk-Soo CHOI	R. Korea	62.50	62.50	0
16	Zhihong Li	China	62.50	81.25	18.75
17	Li Ping	China	68.75	75.00	6.25
18	Muhammad Tariq Khan	Pakistan	87.50	93.75	6.25
Total			69.44	79.51	12.85

Contents of FFS and Content of Training Sections

Time	Contents/action	Note
Preparation	Site selection:	
	Commune, Dist.	
	Selection of IPM area (10 ha) and control area (10 ha)	3 km far from each other
	Carry out baseline survey, consolidate the data, Make Cropping calendar	
Meeting 1	Opening	
	Pre-test	
	Principles of protein bait	
	1-2-3 of fruit fly population monitoring: Instruct farmers to set up the Methyl Eugenol and Cue-Lure in IPM area and FP	Set up traps 2 weeks before FFS start, 5 traps with Methyl Eugenol and 5 with Cue-Lure
Meeting 2	Develop the training topics and training schedule for FFS	
	1-2-3 of fruit fly population monitoring: collect fly adults from each traps at IPM area and FP area, counting the number/species and field data in the FTD sheet	Make available big FTD sheet for each group, so that participants fill in the collected data
	Practice identification of three main fruit flies	
	Insect Zoo: Collect any infested fruits observe symptom of fruit fly infested fruit, keep separately infested fruits in the plastic bottle to observe the larvae/adults emergence and parasitoids	
	Games, theatre, group dynamic activities	
Meeting 3	Ecology, biology, life cycle, damage symptom, potential damage	
	Fruit fly management: - principle of protein bait - field sanitation - principle of pheromone trap - instruction of fruit wrapping	<ul style="list-style-type: none"> - Preparation: 1 liter of bait Ento-pro 150 DD + 9 liters of water + 1 gram of chemical pesticides 2 liters of water poured into the bottle, then pour into mixing pesticides are dissolved, then pour into bottles and more bottles of bait Stir well, then down to 9 liters of water, continue to tan trays for all) - The amount of spray: bait protein (20 liters of fluid / ha), every 4 trees sprayed onto a tree - Spray periodically 7 days / times - Start spray a week before flowering

	1-2-3 of Fruit fly population monitoring: collect fly adults from each traps at IPM area and FP area, counting the number/species and field data in the FTD sheet	
	Insect Zoo	
	Games, theatre, group dynamic activities	
Meeting 4	FFS participants instruct farmers in whole IPM area to spray the protein baits in to plants and do the field sanitation	10 ha, 150 farmers
	1-2-3 of Fruit fly population monitoring: - guide methods sampling and evaluation of damaged fruit per cent, the number of larvae / adult / parasitoids - collect flies from the traps (IPM / FP), count the number of flies in each species and fill in FTD sheet	Instruction of sampling methods take the sampling at IPM / FP fields randomly at harvest time: 3 times / crop season for the crop that harvesting fruits at several times; 1 time / season for plants that harvesting fruit with only one time per season
	Insect Zoo	
	Games, theatre, group dynamic activities	
Meeting 5	FFS participants instruct farmers in whole IPM area to spray the protein baits in to plants and do the field sanitation FFS participants practice of fruit wrapping in the field in IPM area	10 ha, 150 farmers
	1-2-3 of Fruit Fly Population monitoring: - guide methods sampling and evaluation of damaged fruit per cent, the number of larvae / adult / parasitoids - collect flies from the traps (IPM / FP), count the number of flies in each species and fill in FTD sheet	
	Insect Zoo	
	Games, theatre, group dynamic activities	
Meeting 6	FFS participants instruct farmers in whole IPM area to spray the protein baits in to plants and do the field sanitation FFS participants practice of fruit wrapping in the field in IPM area	10 ha, 150 farmers
	1-2-3 of Fruit Fly Population monitoring: - sampling and evaluation of damaged fruit per cent, the number of larvae / adult / parasitoids. - collect flies from the traps (IPM / FP), count the number of flies in each species and fill in FTD sheet	
	Insect Zoo	
	Pesticide risk reduction: spray techniques	
	Games, theatre, group dynamic activities	
Meeting 7	FFS participants instruct farmers in whole IPM area to spray the protein baits in to plants and	10 ha, 150 farmers

	do the field sanitation FFS participants practice of fruit wrapping in the field in IPM area	
	1-2-3 of Fruit Fly Population monitoring: - guide methods sampling and evaluation of damaged fruit per cent, the number of larvae / adult / parasitoids. - collect flies from the traps (IPM / FP), count the number of flies in each species and fill in FTD sheet	
	Discuss the fruit fly management strategies	
	Insect Zoo	
	Games, theatre, group dynamic activities	
Meeting 8	Consolidate the data, reporting, planning for next season	
	Pesticide risk reduction: (dye spray; roots and vessel; pesticides affect the natural enemies); Games, theatre, group dynamic activities	
Meeting 9	Consolidate the data, reporting, planning for next season (Cont.)	
Meeting 10	Field trip day and closing ceremony	

Activities during the APPPC Fruit Fly Management Training Workshop

Day: 20/6/2016



Day: 21/6/2016



Day: 22/6/2016





Day: 23/6/2016





Day: 24/6/2016





Day: 25/6/2016

