

Pests of Horticultural Crops in Bhutan

=Report of Activities in IHPP=

November, 2017

**JICA Short Term Expert, IHPP
Azusa FUJIE**

Project: Integrated Horticulture Promotion Project (IHPP) in the West Central Region

Period as an expert: September 10 – November 8, 2017

Accepted organization: Renewable Natural Resource Research and Development Center (ARDC-Bajo), Department of Agriculture, Ministry of Agriculture and Forests, Royal Government of Bhutan

Object of the activity

- (1) Investigations, identification and management of major pests (Insect pests and diseases) on fruit trees and vegetables in the west central region**
- (2) Transfer to the counterpart of technical information and knowledge on major pests**

Self-introduction

- Azusa FUJI IE (藤 家)
- Born in Kyoto, Japan
- Applied entomologist
- Insect pest researches on rice plants, fruit trees and vegetables during 1969 – 2006 in **Japan** and during 2006 – 2017 in **East Africa**, the **Middle East** and **Asia**



Contents

- (1) Investigation points
- (2) Major pests on fruit trees and vegetables**
- (3) Identification and management of major pests on fruit trees and vegetables
- (4) Native natural enemies to the insect pest of fruit trees and vegetables**
- (5) Appendix

(1) Investigation points



The West Central Region, Bhutan

*** We investigated at 35 points in the west central region.**

Abbr.	Elevation	Point	Investigation date
#1-1	1,220m	Bajo, Wangdue Phodrang	14, 15-Sep
#1-2	1,220m	Bajo, Wangdue Phodrang	29-Sept, 2, 3-Oct
#1-3	1,220m	Bajo, Wangdue Phodrang	21-Oct
#2	1,250m	Phuntsno, Pelri, Punakha	19-Sep
#3	1,250m	Phuntsno, Pelri, Punakha	19-Sep
#4	1,920m	Noobgang, Talo, Punakha	20-Sep
#5	1,840m	Lapsakha, Talo, Punakha	20-Sep
#6	1,520m	Wolakha, Talo, Punakha	20-Sep
#7	1,340m	Damchoe, Kabjisa, Punakha	21-Sep
#8	1,370m	Rimchu, Goenshari, Punakha	21-Sep
#9	1,740m	Jazikha, Shangana, Punakha	21-Sep
#10	1,610m	Silna, Toepisa, Punakha	22-Sep
#11	1,280m	Chimipang, Baap, Punakha	22-Sep
#12	610m	Gewog, Daga, Wangdue Phodrang	25-Sep
#13	640m	Dohamchey, Athang, Wangdue Phodrang	25-Sep
#14	1,510m	Talidoho, Nahi, Wangdi Phodrang	26-Sep
#15	1,630m	Doltochen, Nahi, Wangdi Phodrang	26-Sep
#16	2,070m	Tshokothanglca, Nahi, Wangdi Phodrang	26-Sep

#17	2,190m	Bjaktey, Kazhi, Wangdi Phodrang	27-Sep
#18	2,150m	Bjaktey, Kazhi, Wangdi Phodrang	27-Sep
#19	1,840m	Jagatokha, Kazhi, Wangdi Phodrang	27-Sep
#20	1,190m	Pangthang, Beteni, Tsirang	5-Oct
#21-1	1,180m	Damphu, Klkorthang, Tsirang	5-Oct
#21-1	1,180m	Damphu, Klkorthang, Tsirang	7-Oct
#22	440m	Southern area, Tsirang	6-Oct
#23	300m	Southern area, Tsirang	6-Oct
#24	850m	Noorbuthang, Phuentsenchhu, Tsirang	7-Oct
#25	690m	Sergithong Maeg, Tsirangtoe, Tsirang	7-Oct
#26	580m	Gaicey Kharka, Tsirangtoe, Tsirang	7-Oct
#27	760m	Trashiding, Dagana	17-Oct
#28	980m	Khagochen, KalidzingKha, Dagana	18-Oct
#29	870m	Baleygang, Gozhi, Dagana	18-Oct
#30	880m	Baleygang, Gozhi, Dagana	18-Oct
#31	924m	Baleygang, Gozhi, Dagana	18-Oct
#32	1,030m	Lower Gozhi, Gozhi, Dagana	18-Oct
#33	1,280m	Middle Gozhi, Gozhi, Dagana	18-Oct
#34	836m	Lower Tsendagang, Tsendagang, Dagana	19-Oct
#35	845m	Lower Gesarling, Gesarling, Dagana	19-Oct



ARDC-Bajo



ARDC-Bajo field



PD: Mr. Pema Chofil



Staffs

Program director and staffs !
Thank you very much for your kindness and support.



Investigated fields
We were supported
by farmers and
extension officers.





**Ugyen san is investigating.
I have hope for him
as an applied entomologist.**

(2) Major pests on fruit trees and vegetables

Remarkable pests for wide-area occurrences

Type	Pest	Crop
Wide areas / Continuous occurrence	Fruit flies (<i>Bactrocera minax</i> , <i>Bactrocera dorsalis</i> species complex, etc.)	Fruit trees, Vegetables
	Longhorn beetles	Fruit trees
	Citrus greening disease / Citrus psyllid (Vector insect: <i>Diaphorina citri</i>)	Citrus
Wide areas / Outbreak	Army worms (<i>Mamestra brassicae</i> , <i>Spodoptera litura</i> , <i>Mythimna separata</i> etc.)	Vegetable, Millet, Young fruit trees
Wide areas / Unclarification	Foot rot symptom	Fruit trees, Vegetables
	Damping-off symptom	Chili

*** Refer to attached papers on countermeasures.**



Fruit tree pests

*** Major fruit tree pests are introduced.**

Major pests on fruit trees

Order	Citrus	Persimmon	Pear	Apple	Grape
Insect pests					
1	Fruit flies ミバエ類	Fruit flies ミバエ類	Fruit flies ミバエ類	Longhorn beetles カミキリムシ類	Scarabs コガネムシ類
2	Citrus psyllid ミカンキジラミ (<i>Diaphorina citri</i>)	Stink bugs カメムシ類 (<i>Plautia crossota</i> etc)	Longhorn beetles カミキリムシ類	Scales カイガラムシ類	Leaf beetles ハムシ類
3	Longhorn beetles カミキリムシ類		Stink bugs カメムシ類 (<i>Plautia crossota</i> etc)		
4	Scales カイガラムシ類		Spider mites ハダニ類		
5	Stink bugs カメムシ類 (<i>Plautia crossota</i> etc.)		Aphids アブラムシ類		
6	Citrus leaf miners ミカンハモグリガ (<i>Phyllocnistis citrella</i>)		Cochilid moth イラガ類		
7	Aphids アブラムシ類		Tussock moths ドクガ類		
8	Cochilid moth イラガ類		Whitflies コナジラミ類		

We observed
various insect
pests on fruit
trees.

Order	Citrus	Persimmon	Pear
Diseases			
1	Citrus greening disease カンキツグリーンング病 <i>(Candidatus Liberibacter asiaticus)</i>	Leaf spot 落葉病	Scab (Probably) 黒星病
2	Foot rot symptom 裾枯れ症状		
3	Orange scab そうか病		
4	Powdery mildew うどんこ病		
5	Sooty mold スス病		

We observed various diseases on fruit trees.

[Citrus 1] Fruit flies



*** We have many kinds of fruit flies. In Bhutan, fruit flies were investigated in 2013 by Dr. Moriya, a JICA expert.**

[Citrus 2] Citrus psyllid

This insect (*Diaphoria citri*) is a vector of citrus greening bacteria. We could not find this insect. But a kind of psyllidae (*Diaphoria communis*), which is a closely-related species of the citrus psyllid, was found on host plants, curry leaf.



[Citrus 3] Longhorn beetles



*** Fruit trees are withered and killed by larvae. Adults bite shoots.**

[Citrus 4] Scales



*** Several kinds of scales are infest with citrus trees, and cause severe damage.**

[Citrus 5] Stink bugs (*Plautia crossota* etc.)



- * Several kinds of stink bugs (Pentatomidae and Acanthosomatidae) attack fruits. In Japan, the outbreak of bugs sometimes occur.
- * The bug remarkably decrease the quality of fruits.

[Citrus 6] Citrus leaf miners (*Phyllocnistis citrella*)



* The damage by citrus leaf miners is apparently severe, but the actual damage is a little.

[Citrus 7] Aphids



*** We can disregard aphids under normal occurrence conditions.**

[Citrus 8] Oriental moths (Eudeidae)



- * The larva of oriental moths is poisonous.
- * We should pay attention to the larvae.

[Citrus 9] Swallowtail butterflies



*** We can disregard swallowtail butterflies under normal occurrence conditions.**

[Citrus 10: Others]



Common cutworm
(*Spodoptera litura*)



Nails



Whiteflies

*** The outbreak of common cutworms and whiteflies often occur in vinyl plastic houses.**

[Citrus 11] Citrus greening disease



- * This is the most important disease, which is transferred by the vector, citrus psyllid.
- * Lemon trees and “Bun-tan” trees are comparatively strong to this disease.

[Citrus 12] Root rot symptom



*** Citrus trees, which have this symptom, finally wither and die. We observed same symptom on several crops. The cause is unknown.**

[Citrus 13] Scab



*** This disease is severe, and occurs under humid conditions. So we should make well-ventilated conditions.**

[Citrus 14] Powdery mildew



*** We can disregard this disease under normal occurrence conditions.**

[Citrus 15] Sooty mold



*** This disease occur on the excrement of some kinds of insects such as whiteflies, scales and aphids.**

[Persimmon 1] Fruit flies



*** Fruit flies attack the fruit of deciduous trees.**

[Persimmon 2] Leaf spots



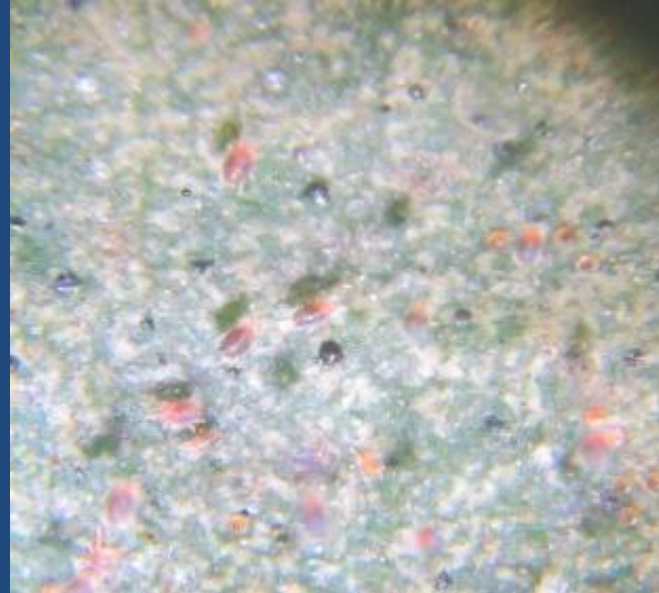
*** We can disregard this disease under normal occurrence conditions.**

[Pear 1] Fruit flies



*** Pear fruits are also damaged by fruit flies.**

[Pear 2] Longhorn beetles and Spider mites



- * The adult of beetles bites branches. Larvae inhabit into trunks and branches of pear trees.
- * We can disregard spider mites under normal occurrence conditions.

[Pear 3] Aphids (*Nippolachnus piri* etc.)



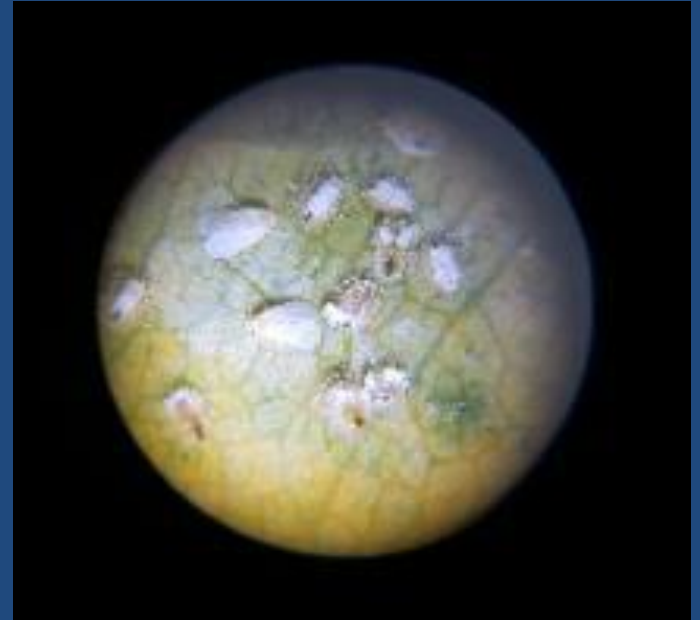
***We observed several kinds of aphids on pear trees.**

[Pear 4] Oriental moths (Eudeidae) and Tussock moths (Lymantriidae)



- * The larva of these moths is poisonous.
- * We should pay attention to the larvae.

[Pear 5] White flies



*** We can disregard whiteflies under normal occurrence conditions.**

[Apple] Longhorn beetles and Scales

Scales



* These insect pests are very dangerous, because they kill trees or attack fruits.

Damage caused by longhorn beetles

[Grape] Scarabs and Leaf beetles



*** Scarabs severely eat the root of fruit trees.**

[Walnut] Longhorn beetles and Bagworm moths

By longhorn
beetle larvae



*** Longhorn beetles are very dangerous, because they kill trees.**

By longhorn
beetle adults



Bagworm moths



[Others: Guava and Dragon fruit] Fruit borer moths and Aphids



Fruit borer moths (Guava)



Aphids (Dragon fruit)



Vegetable pests

Order	Cabbage	Radish	Indian mustard	Beans	Chili
Insect pests					
1	Aphids アブラムシ類(<i>Myzus persicae</i> etc.)	Aphids アブラムシ類(<i>Myzus persicae</i> etc.)	Armyworms ヨトウムシ類 (<i>Mamestra brassicae</i> , <i>Spodoptera litura</i> , <i>Mythimna separata</i> , etc.)	Armyworms ヨトウムシ類 (<i>Mamestra brassicae</i> , <i>Spodoptera litura</i> , <i>Mythimna separata</i> ., etc.)	Armyworms ヨトウムシ類 (<i>Mamestra brassicae</i> , <i>Spodoptera litura</i> , <i>Mythimna separata</i> , etc.)
2	Cutworms ネキリムシ類 (<i>Agrotice ipsilon</i> , <i>Agrotis segetum</i> . etc.)	Free beetles ノミハムシ類 (<i>Phyllotreta striolata</i>)	Aphids アブラムシ類(<i>Myzus persicae</i> etc.)	Pod borers マメシंकイムシ類	Fruit flies ミバエ類
3	Armyworms ヨトウムシ類 (<i>Mamestra brassicae</i> , <i>Spodoptera litura</i> , <i>Mythimna separata</i> . etc.)	Cutworms ネキリムシ類 (<i>Agrotice ipsilon</i> , <i>Agrotis segetum</i> , etc.)	Grasshoppers バッタ類	Stink bugs カメムシ類	Aphids アブラムシ類(<i>Myzus persicae</i> etc.)
4	Cabbage bugs ナガメ類	Armyworms ヨトウムシ類 (<i>Mamestra brassicae</i> , <i>Spodoptera litura</i> , <i>Mythimna separata</i> , etc.)	Cabbage bugs ナガメ類	Whitflies コナジラミ類	Termites シロアリ類
5	Slugs ナメクジ類	Grasshoppers バッタ類	Weevils ゾウムシ類	Leafhoppers ヨコバイ類	Cutworms ネキリムシ類 (<i>Agrotice ipsilon</i> , <i>Agrotis segetum</i> etc.)
6		Weevils ゾウムシ類	Leaf beetles ハムシ類	Borer moths メイガ類	

We observed various insect pests on vegetables.

Order	Cabbage	Radish	Indian mustard	Beans	Chili
Diseases					
1		Virus disease ウイルス病		Foot rot symptom 裾枯れ症状	Damping-off symptom 立ち枯れ症状
2					Foot rot symptom 裾枯れ症状
3					Virus disease ウイルス病

These diseases are problem on vegetables.

[Cabbage 1] Army worms (*Mamestra brassicae*, *Spodoptera litura*, etc.) and cutworms (*Agrotis ipsilon* etc.)



Armyworms and
cabbage damage



Cutworms

*** Crops are severely damaged
by army worm larvae.**

[Cabbage 2] Cabbage bugs and Slugs



Cabbage bugs

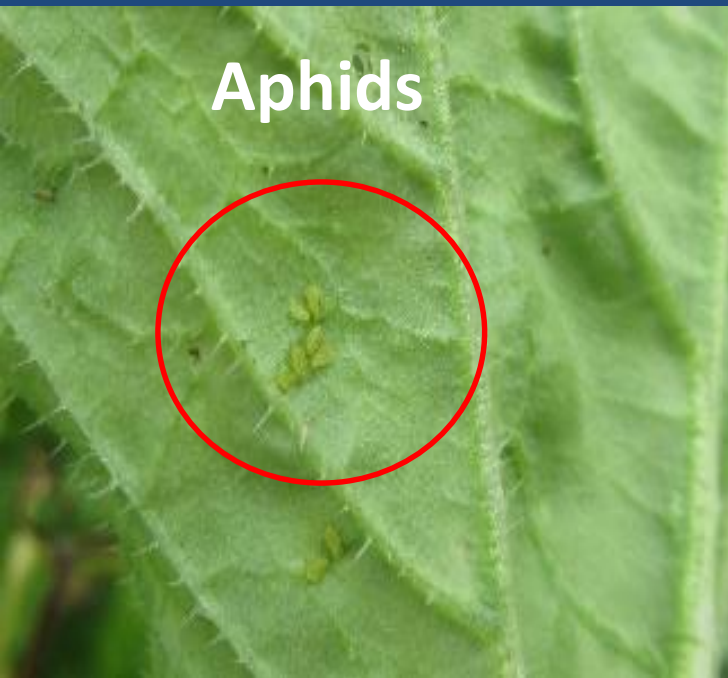


Slugs

*** We can disregard them under normal occurrence conditions.**

[Radish 1] Aphids and Flea beetles

(*Myzus persicae* and *Phyllotreta striolata*)



- * Aphids are the vector of virus diseases.
- * The adult of flea beetles eats leaves, and the larva eats roots.

[Radish 2] Cutworms and Army worms



Cutworm damage



*** Cutworm larvae bit stems, and missing plants are caused by damage.**

[Radish 3] Grasshoppers, Weevils and Cabbage bugs



Weevils



Cabbage bugs



Grasshoppers

*** We can disregard these insect pests under normal occurrence conditions.**

[Radish 4] Virus disease



*** Aphids infect the crop with viruses. So we should control aphids.**

[Indian mustard 1] Army worms, Aphids and Grasshoppers



Armyworms



Aphids



Grasshoppers

*** Army worms eat violently leaves.**

[Indian mustard 2] Cabbage beetles, Weevils and Leaf beetles



Cabbage bugs



Weevils



Leaf beetles

*** We can disregard these insect pests
under normal occurrence conditions.**

[Beans 1] Army worms (*Spodoptera litura*, *Mythimna separate*, etc.)



*** Army worms eat violently leaves.**

[Beans 2] Stink bugs, Whiteflies and Pod borers



(Plautia crossota)

Stink bugs

(Adult: Left, Larva: Right)

*** Pod borers cause severe yield loss.**



Whiteflies



Pod borers

[Beans 3] Foot rot symptom



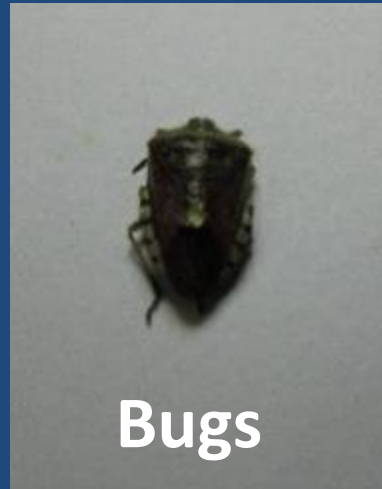
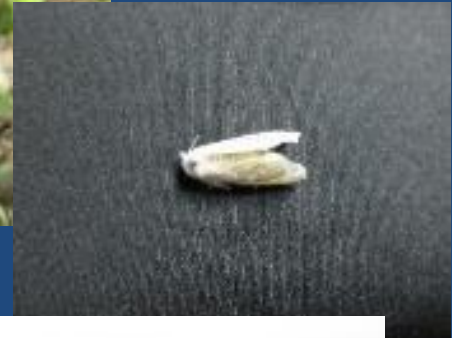
*** The symptom looks like that of citrus trees.**

[Chili 1] Fruit flies, Army worms and Bugs



Fruit flies

*** Fruits are damaged by fruit flies and leaves by army worms.**



Bugs



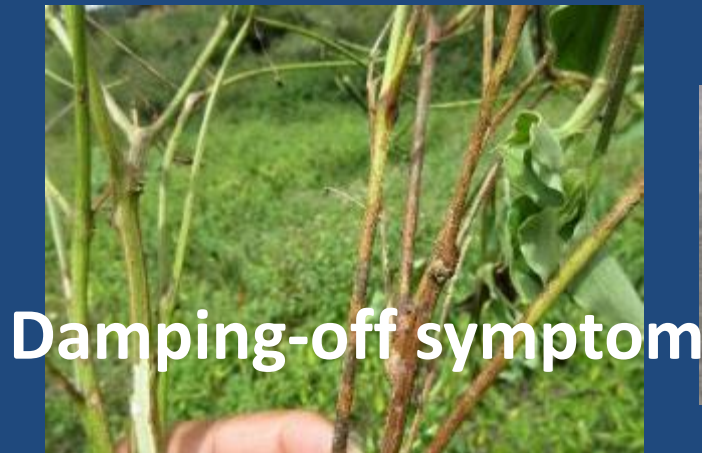
Army worms

[Chili 2] Aphids and Termites



- * Aphids transmit virus diseases.
- * Termites sometimes cause severe damage.

[Chili 3] Damping-off symptom and Foot rot symptom



Foot rot symptom



*** These are the most severe diseases on chili.**

[Chili 4] Virus disease



*** The virus is transmitted by aphids, and this disease cause severe yield loss.**

[Others 1: Tomato and Eggplant]

Fruit flies and Lepidopteran borers



Damaged by fruit flies



Damaged by borers

*** Fruit flies, which are dangerous insect pests on fruit trees, attack fruit vegetables, too.**

[Others 2: Millet] Army worms (*Mythimna separate* etc.)



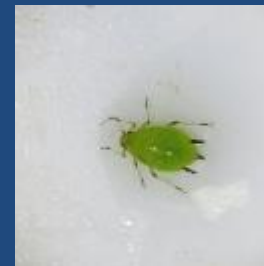
*** The outbreak of army worms often occur.**

(3) Identification and management of major pests on fruit trees and vegetables

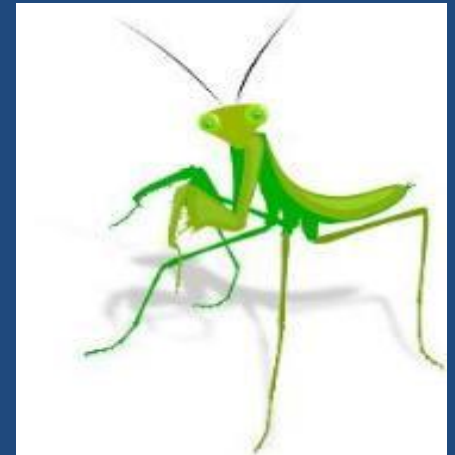


We prepared pest samples and photos for the identification.

Please refer to attached papers, photos and original samples on the identification and management of major pests.



(4) Native natural enemies to the insect of fruit trees and vegetables



Native natural enemies, which carry out the important role for controlling insect pests in fields, are introduced. They are indispensable for pest management in organic agriculture.

Major native natural on fruit trees, vegetables and weeds

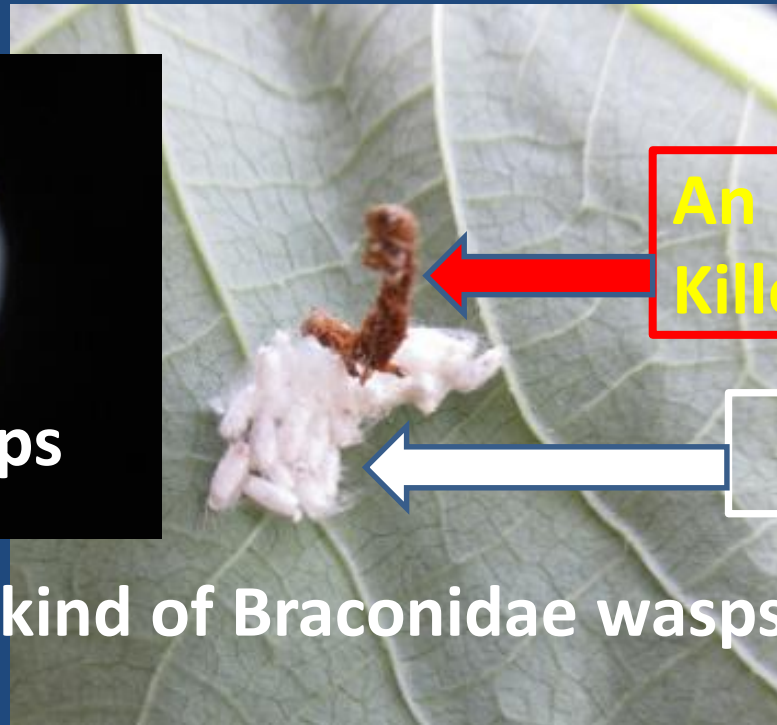
Order	Citrus		Persimmon	Pear	Apple	Walnut	Weed
1	Ladybird beetles テントウムシ類		Ladybird beetles テントウムシ類	Ladybird beetles テントウムシ類	Ladybird beetles テントウムシ類	Spiders クモ類	Assassin bugs サシガメ類
2	Predacious mites 捕食性ダニ類		Spiders クモ類	Spiders クモ類			Dragon flies トンボ類
3	Spiders クモ類						Earwig ハサミムシ類
4	We observed these natural enemies. The existence is rather few, except ladybird beetles.						Ladybird beetles テントウムシ類
5							Miridae bugs カスミカメムシ類
6							Parasitic flies 寄生蠅類
7	Order	Cabbage	Radish	Indian mustard	Beansn	Chili	Pawasitic wasps 寄生蜂類
8	1	Ladybird beetle テントウムシ類	Big-eyed bugs オオメカメムシ類	Ladybird beetles テントウムシ類	Assassin bugs サシガメ類	Hover flies ヒラタアブ類	Spiders クモ類
	2	Mantises カマキリ類	Ladybird beetles テントウムシ類		A kind of Braconidae wasp コマユバチの一種	Ladybird beetles テントウムシ類	
	3		Spisers クモ類		Ladybird beetles テントウムシ類		



*** We observed many ladybird beetles, which are eat small insect pests such as aphids and scales.**



An adult of wasps



An army worm larva
Killed by wasps

Cocoons

A kind of Braconidae wasps

This wasp adult lays eggs into the body of army worm larvae. Wasp larvae developed in the body of army worm larvae emerge outside, and make cocoons (pupae). Wasps emerged from cocoons attack some other army worm larvae.

An infested aphid



A un-infested aphid

**An aphid infested with
parasitic wasps.**

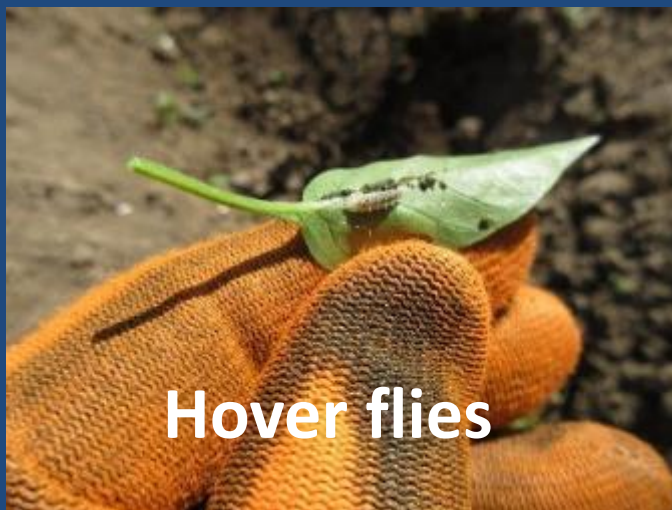
*** Parasitic wasps as native natural enemies carry out the important role for controlling insect pests in fields.**



Assassin bugs



Dragon flies



Hover flies



Mirid bugs (Miridae)

*** Mirid bugs contain natural enemies and insect pests.**



Parasitic flies

(5) Appendix



Agriculture with IPM in Japan

- In Japan the agriculture with the integrated pest management (IPM) is carried out.
- IPM was recommended based on the regret for the heavy use of agrochemicals. Globally, IPM has been recognized at present.
- We sure that three steps, (1) Precaution, (2) Judgment and (3) Utilizations of all suitable control methods, are important to practice IPM in Japan (MAFF, Japan 2005).

IPM system in Japan

(Ministry of Agriculture, Forestry and Fisheries, in 2005)

2. Judgments for controlling pests

- * Official forecasting information
- * Pest occurrence investigations
- * Economic injury level

1. Precaution against pest occurrences

- * Cultural control methods
- * Resistance varieties
- * Native natural enemies
- * Pheromone formulations

3. Utilizations of all suitable control methods

- * Biological control methods
- * Physical control methods
- * Chemical control methods

The system has three steps. It is necessary to develop various technologies at each step.

Organic agriculture

Definition of organic agriculture by IFOAM

“Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved.”

IFOAM (NGO): International Federation of Organic Agriculture Movements (國際有機農業運動連盟)

Organic agriculture in Japan

- (1) No agrochemicals
- (2) No chemical fertilizers
- (3) No transgenic crops
- (4) Decrease of the impact against the natural environment



In Japan, the definition of an organic agriculture, which composed of four factors, is simple and clear. However, the organic agriculture system is secondary, and the agriculture with IPM is main.

Changes of agriculture systems related to the pest management in Japan

1st : Agriculture with traditional pest control (To 1950)



2nd : Agriculture with chemical pest control (1950–1990)



3rd : Agriculture with IPM (1990–Now)



4th : Agriculture with bio-intensive IPM (Future)



Organic agriculture
(Past–future)

Main system

Sub system

**Let's construct
a novel pest management theory**

- **Organic agriculture, which is a sustainable production system, is ideal.**
- **But this system is negative against pest control, although crops are always exposed to pest damage.**
- **We should produce high quality crops and increase the crop yield in agriculture.**

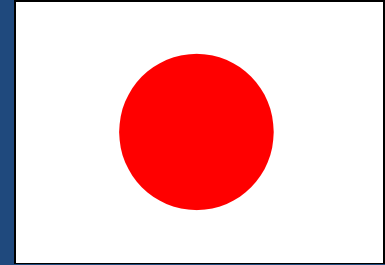
***Why don't you consider
the agriculture system
without agrochemicals,
which is positive
against pest control ?***

Acknowledgement

This activity is carried out as a part of the activity of IHPP (Messrs. Tomiyasu, Sasaki and Yuasa), Kingdom of Bhutan.

- Renewable Natural Resource Research and Development Center (ARDC-Bajo)
- Extension officers and farmers in the west central region
- Ministry of Agriculture and Forests
- JICA Bhutan office
- JICA head office





Tank you very much

どうもありがとうございます

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