Technical Cooperation Project for Agricultural Productivity and Quality Improvement in Myanmar

Project Report

JAICAF ジェイカフ

March 2018

Japan Association for International Collaboration of Agriculture and Forestry

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of Agriculture and Forestry

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Foreword

Japan Association for International Collaboration of Agriculture and Forestry, JAICAF, implemented the survey and technical cooperation project in Myanmar aiming at the productivity and quality improvement of its sesame production receiving funding from the Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF).

Sesame is one of the major oil crops in Myanmar and important cash crop for the farmers. The Government of Myanmar strives to expand the production and improve the quality of the oil crops including sesame. At the same time, there is a demand to support the production sites of the high quality sesame from the trade companies, food manufacturers and consumers of Japan, who rely on imports from other countries for most of edible sesame. In particular, the imports of black sesame from Myanmar account for more than eighty percent of total black sesame consumption in Japan. However, there are many issues to stably ensure the qualified ones which fit to the Japanese market.

For these backgrounds, we conducted the survey and technical cooperation for the production site focusing on the central dry zone, main production area of black sesame. We dispatched the experts of the soil and fertilization to improve the sesame productivity in addition to the experts on pesticide management and insects for the quality problem such as pesticide residue. We implemented the extension activities through holding workshops and manual distribution based on the field survey.

This report summarizes the activities and outcomes for the fiscal year 2017. Many supports and supervisions were given by the dispatched experts and Project Evaluation & Review Committee members for the implementation and operation of this project. Also, many cooperation were provided, such as important information provision, arrangement with the visiting destinations and accompaniment to the dispatched experts from Ministry of Agriculture, Livestock and Irrigation of Myanmar, Embassy of Japan in Myanmar and Japan International Cooperation Agency (JICA) - Rural Development Department, Myanmar office, Agriculture and Rural advisors, "Project for Development of Water Saving Agriculture Technology in the Central Dry Zone", "Project for Capacity Development of Yezin Agricultural University" and "Project for Profitable Irrigated Agriculture in Western Bago Region", and private companies. We are deeply grateful for all of your support.

We would like to note that this report does not represent the opinion of MAFF or Japanese government but was prepared under the responsibility of JAICAF.

March 2013

Japan Association for International Collaboration of Agriculture and Forestry
President Eiji Matsubara

photo 1: sesame field

photo 2: sesame shipper

photo 3: agricultural material shop

photo 4: sesame plants

photo 5: DAR promoting "Sesame for High-income"

photo 6: DAR recommends IPM for target yield

photo 7: soil survey

photo 8: soil laboratory of DOA

photo 9: training on soil diagnosis

photo 10: surveying the profile of the soil

photo 11: wind-erosion protection

photo 12: water-erosion

photo 13: survey on insect

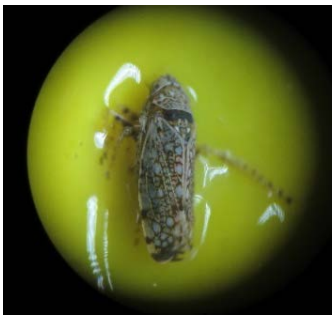

photo 14: captured Leafhoppers

photo 15: proboscis of Stink bugs (sucking sesames)

photo 16: Phytoplasma transmitted by Leafhoppers

photo 17: damages on sesame by a species of Pyralid moths

photo 18: larva of a Pyralid moths (black spots on the back)

photo 19: pilled-drying

photo 20: stand-drying

photo 21: threshing by beating

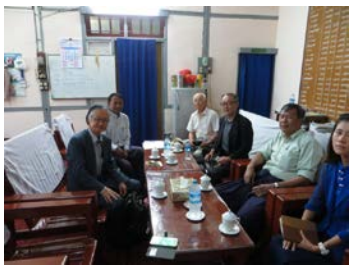

photo 22: activity briefing session at DOA Magway

photo 23: workshop in Magway

photo 24: workshop in Nay Pyi Taw

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Abbreviation

DAR	Department of Agriculture Research
DOA	Department of Agriculture
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Statistical Database
GAP	Good Agricultural Practice
ITC	International Trade Centre
JICA	Japan International Cooperation Agency
MOAI	Ministry of Agriculture and Irrigation
MOALI	Ministry of Agriculture, Livestock and Irrigation
MPBSA	Myanmar Pulses, Beans & Sesame Seeds Merchants Association
T/S	Township
USDA	United States Department of Agriculture
YAU	Yezin Agricultural University

Chapter 1 Project Outline

1. Purpose of the Project

A large part of the population in Myanmar is living in the rural area engaging in agriculture. The country has a great potential in developing the food industry as it is expected to sustain economic growth with the substantial size of population. Agricultural technologies are useful to increase the income of the farmers. Improving the farmers' productivity and supplying agricultural products with adequate quality and quantity to the global market will contribute to the growth of the country and improvement of farmer's livelihood.

In this project, we aim to improve the productivity and earning capacity of the farmers in Myanmar and to encourage Japanese companies to create stronger relationship with Myanmar in the food related industries through training and extension of agricultural technology, such as soil improvement, proper use of the pesticides and fertilizers and appropriate postharvest management.

1) Project Background

(1) Main agricultural products in Myanmar

It is important for Myanmar to improve the agricultural productivity and income level of the farmers as the contribution of this sector to GDP is about 30% and below 20% to export income although it is an agricultural country where more than 60% of the labor population is engaging in the agriculture.[1] The agricultural sector is positioned as the most important one in the national growth strategy and the keystone of economic growth. The Ministry of Agriculture, Livestock and Irrigation (MOALI) aims to improve the productivity and quality designating 10 crops; rice, maize, groundnut, sesame, sunflower, black gram, green gram, pigeon pea, sugarcane and cotton as the most important crops for the country,.

Among them, sesame is the essential crop for the Myanmar's food culture as it is used for seasonings, sweets and snacks. One of the most important use of sesame is for cooking oil and its strained lees after squeezing oil are used as the livestock feed. Sesame is also important as export crop. It is exported to the world and especially to East Asian countries, China, Japan or Korea which account for the important part of export income of Myanmar. According to the FAO production quantity ranking of 2013, the sesame production quantity of Myanmar was sixth in the world with 540 kton (figure 1-1). International Trade Centre (ITC) ranked sesame as one of the top 20 items that have the high export potential in Myanmar in its report to evidence the further

[1] Department of Planning, Ministry of Agriculture, Livestock and Irrigation: Myanmar Agriculture in Brief 2015, September 2015

possibility of export increase. In recent years, as China who is the major sesame producer country turned to the sesame importer, it is considered that the sesame from Myanmar will continue to increase its presence in the international market.

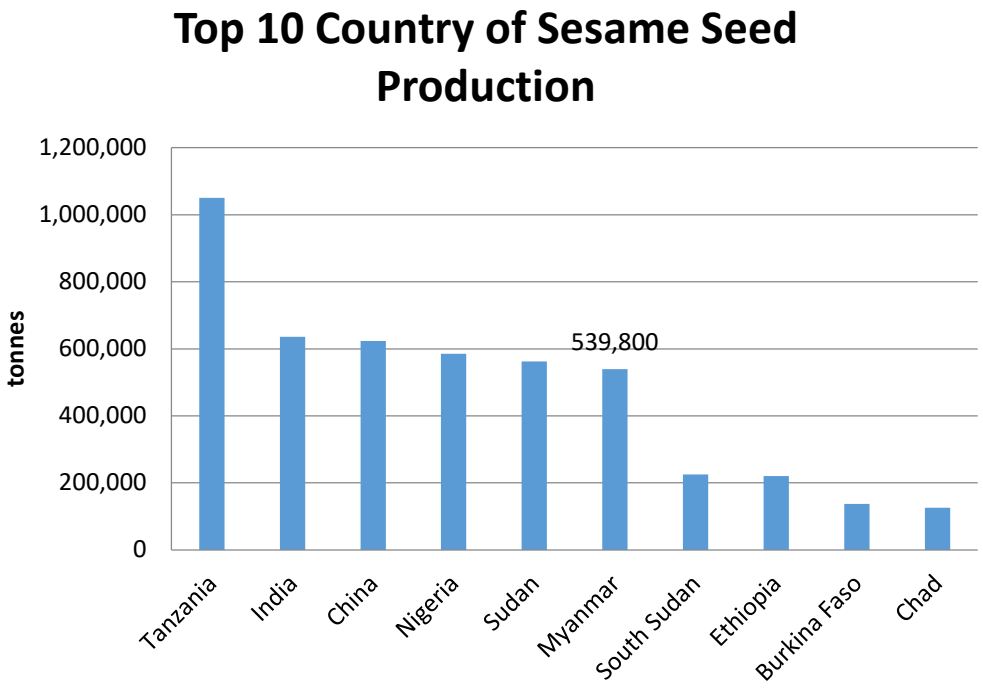

Figure 1-1. Top 10 county of Sesame Seed Production (FAO Stat, 2013)

(2) Market needs

Demand for sesame in the world is increasing with recent health consciousness as a background. The stable sesame supply is the major issue for Japan who rely almost all quantity of domestic sesame consumption on the import. There is a competition for high quality sesame as China increasing its import and the demand from Middle East also increased. Myanmar is the fifth largest sesame exporting country for Japan following Nigeria, Tanzania, Burkina Faso and Paraguay. As Japan is the second largest importing country for Myanmar following China, it can be said that the sesame trading is important to both countries.

(3) Potential for improvement in Myanmar's sesame production

The sesame is cultivated as a second crop to the principal food, rice. In many cases, sesame's cultivation technology improvement lags behind that of other major crops such as rice despite its importance for Myanmar's food culture. As the sesame is relatively tolerant to dry weather and can be grown on the low fertile soil, it is difficult to say that the popularization of irrigation

technology or fertilization technology has been proactively implemented. However, this means that there is a potential to increase its yield with technology upgrade. Productivity improvement can be expected if fertilizer and pesticides were properly used after clarifying the situation of cropping system and soil management. Also, stable production can be realized by improving the soil management technology comprehending the soil characteristics or precipitation pattern differed by region.

Most of the sesame is cultivated by the small scale farmers as it is difficult to introduce machinery for harvest since sesame seeds easily fall. Since most sesame farmers are small scale farmers, it is very difficult to uphold the thorough pesticides management in sesame cultivation involving all farmers. As a result, the violations of pesticide residue standards of the imported sesame to Japan are often reported. Twelve residual standards violations of imidacloprid (neonicotinoid insecticide) with imported sesames from Myanmar to Japan were reported between April 2014 and January 2017[2]. The typical insects for sesame are Aphids, Sphinx moths, Stink bugs, Scarabs or Owlet moths and it is necessary to clarify whether the proper quantity of pesticides are used at the appropriate time in Myanmar as the most appropriate time for exterminating is the initial stage of growth. It is necessary to identify the situation of pesticide use in Myanmar and to identify what information is needed for farmers in order to achieve safe and high quality sesame export.

2) Target of the Project

The project focused on the sesame as the target crop and clarified the status and issues of the sesame cultivation by dispatching the experts of soil, pesticides and insects to conduct the technical guidance on soil management, appropriate usage of pesticides and insect pest control following the targets stated below.

- to give the guidance on the appropriate soil management by comprehending the current sesame production condition, cropping system and soil management status of the target region
- to give guidance on effective insect pest control methods by comprehending the current situation of insects and their control method of the target region
- to give guidance on the appropriate pesticides-use by comprehending its current status in the target region

We aimed extending the technology by preparing and distributing the manual as it is difficult to transfer the adequate technology properly in only one year. The expected achievements of the

[2] aggregated from the violation cases prompt report by the Department of Environmental Health and Food Safety, Pharmaceutical Safety and Environmental Health Bureau, Ministry of Health, Labour and Welfare

project are as follows.

- the issues in sesame production of the target region are clarified and the implementable countermeasures will be identified - the current situation of soil management in the target region is clarified and the appropriate soil management method will be adopted - the effective insect pest control method, fit to the pest occurrence situation of the target region, will be understood - the importance of the appropriate use of pesticides will be understood

3) Extension of Project Achievements

We verified the issues identified in the preliminary survey at an expert panel, discussed the much-needed technologies among the technologies related to the soil management, insect pest control or appropriate use of pesticides at a workshop, and collected the information to make the contents more fit to the actual condition of target region. We prepared the manual after returning home and distributed to the institutions concerned with the report.

4) Target Region

Myanmar can be divided into four climatic zones, hilly mountainous zone, central dry zone, delta zone and neritic zone, and the sesame is mainly cultivated in the central dry zone. In the central dry zone, cultivations of the groundnut, green gram, pigeon pea and rice are also common. The sesame is the important cash crop for the farmers in the central dry zone because of its high profitability ratio although mechanization of sesame production is difficult and more labor cost for harvest and threshing is required. The central dry zone consists of three areas, Mandalay Region, Magway Region and Sagaing Region, as shown in the figure 1-2. The sesame production volume of these regions account for about 90% of the country. We selected Magway Region as the target region considering sesame cultivation situation and accessibility. In addition, we narrowed down the target T/S (Township[3]) discussing with the Ministry of Agriculture, Livestock and Irrigation (MOALI), Department of Agriculture (DOA) at the preliminary survey.

[3] One of the administrative unit of Myanmar. Township (T/S) consists of city/town or village/tract.

Figure 1-2. Map of Myanmar (Australian National University)

2. Contents of the Project

We supported the Myanmar sesame farmers in improving the productivity in order to increase their income and to meet the demand for quality sesame in the global market. We first conducted preliminary survey by surveying the demand from supply-chain stakeholders and also surveying the current situation of sesame farmers in Magway regions. Secondly, we conducted technical guidance and workshop to the local farmers and extension officers. In addition to that, we prepared manual for extension officers to use so that technical training can be sustainably implemented at field.

1) Preliminary Survey

We deliberated the teaching contents required for stable production and quality improvement

by comprehending the issues related to the quality and quantity of agricultural products conducting hearing survey from the local Japanese companies, the government and the institutions concerned by dispatching the experts from Japan to Myanmar. At the same time, we prepared the technical guidance by determining the technical guidance target region discussing with DOA, confirming the sesame cultivation situation and narrowing down the technologies to coach and the target farmers.

Before dispatching the experts to Myanmar, we had collected the information, visited to the sesame importers to confirm their needs and conducted the hearing investigation also from the food manufacturers who deal sesame after dispatching.

Members	Survey period	Contents
Minoru Yoshida (JAICAF Technical Advisor) Mari Tanaka (JAICAF Researcher)	June 5 - June 14 (for 10 days)	1. Confirming the issues on quality and quantity of the agricultural products 2. In the technical guidance target area, (i) check the status of sesame cultivation (ii) check the technologies needed (iii) determine the guidance target area

2) Evaluation and examination of the technical guidance contents

The Project Evaluation & Review Committee was implemented as follows.

[The 1st Project Evaluation & Review Committee]
Time and date: June 19, 2017 (Mon), 3:00 pm - 5:00 pm
Subject: *Implementation plan of the project for this year
*Results of the preliminary survey
*Plan of technical guidance for agricultural productivity and quality improvement

[The 2nd Project Evaluation & Review Committee]
Time and date: July 18, 2017 (Tue), 3:00 pm - 5:00 pm
Subject: * Report on the 1st technical guidance for agricultural productivity and quality improvement
* Plan for the 2nd technical guidance and workshop for agricultural productivity and quality improvement

Members of the project evaluation & review committee

Name	Title	Specialized Field
Dr. Kenji Irie	Professor, Tokyo University of Agriculture, Faculty of International Agriculture and Food Studies, Department of International Agricultural Development	Genetic resource (Rice)
Dr. Ikuko Okamoto	Professor, Toyo University, Faculty of Regional Development Studies, Department of Regional Development Studies	Agricultural economy
Dr. Masaaki Suzuki	JAICAF Technical Advisor	Soil improvement
Dr. Osamu Nakagaki	VSOC Co., Ltd., Representative Director	Dryland agriculture
Dr. Machito Mihara	Institute of Environmental Rehabilitation and Conservation (ERECON), President	Environmental rehabilitation and conservation

3) Technical guidance

We implemented the technical guidance to produce the safe and high-quality agricultural products taking the environment into consideration, such as soil improvement and proper use of pesticides, to farmers and extension officer by dispatching the experts to the target areas. We shared the technologies useful for soil management, insect pest control and proper use of pesticides dispatching the experts on soil, insect pests and pesticides, and prepared the manual to popularize the contents of technical guidance.

(i) Implementation of the technical guidance

Experts	Period of training	Contents of trainings
Dr. Masaaki Suzuki (soil improvement /fertilizer)	June 21 - June 30 July 24 - August 8 (for 26 days)	- Soil management: investigated the soil characteristics. - Supervised the maintenance and management of the soil fertility based on the investigation results.
Dr. Azusa Fujiie (insect pests)	June 21 - June 30 July 24 - August 8 (for 26 days)	- Pest control: deliberated the pest investigation method and investigated their actual generation status (species, generation density or damages) and native natural

		enemies. Supervised the pest control methods based on the investigation results.
Dr. Masahiko Kuwahara (pesticides)	June 21 - June 30 (for 10 days)	- Proper use of pesticides: investigated the actual use status of the pesticides. Supervised the proper use of pesticides based on the investigation results.

(ii) Agricultural equipment and materials used

Field	Type	Utilization method in trainings	Contents of trainings
Soil	Soil probe, pH meter, EC meter, Soil testing kit	Used for simple diagnosis of the local soil and to confirm the training contents of the soil management method	Trained the extension officers on the simple soil diagnosis method through OJT. We taught the importance of the soil diagnostics and soil diagnosis method, and the fertilization method based on the results of soil diagnostics at the workshop.
Insect	Compact stereoscopic microscope	Confirming the actual generation status of the pests and natural enemies, coach the pest control methods based on the acquired perception.	Trained the extension officers on investigation methods for actual generation status of insect pests and natural enemies through OJT. Coach and popularize the insect pest control methods and the appropriate pesticides use.

4) Technology extension

We validated the technical guidance contents holding the follow-up workshop on site after implementing the technical guidance to popularize the achievements of this project. We prepared the manual to make it possible to extend them to distribute to the governmental agencies and related stakeholders. In addition, we hope this report will be useful for those who would like to learn the situation of sesame production and about soil management, insect pest management and proper use of pesticide. This report is also published on JAICAF's website.

(i) Manual

Type	No. of copies	Distribution
- soil management method for sesame in Magway - control methods of insect pests and natural enemies for sesame in Magway	100 copies in Burmese	DOA staff (10) DAR staff (10) T/S officers (80)

(ii) Workshop

Time	Venue	Contents
August	DOA Magway office DOA Nay Pyi Taw HQ	- soil management method for sesame in Magway - control methods of insect pests and natural enemies for sesame in Magway

(iii) Report

No. of copies	Distribution
Japanese 50 copies	MAFF (10), Ministry of Foreign Affairs (MOFA) (2), Cooperative firms (5), Diplomatic establishments abroad (2), JICA (5), Cooperative organizations/International organizations (5), Evaluation & Review Committee members (6), Dispatched experts (5) and spares, 50 in total
English 50 copies	MAFF (10), MOFA (2), Cooperative firms (5), JICA (2), Diplomatic establishments in Japan (2), Myanmar MOALI - DOA (5), - Department of Agricultural Research (DAR) (5), Diplomatic establishments abroad (2), Evaluation & Review Committee members (4), Dispatched experts (3) and spares, 50 in total

Chapter 2 Preliminary Survey

Members: Dr. Minoru Yoshida, Technical Advisor, JAICAF
Ms. Mari Tanaka, Researcher, JAICAF

Period of survey: June 5 - June 14, 2017 (for 10 days)

Survey schedule:

Date	Activity	lodging
June 5 (Mon)	Narita - Yangon (ANA: NH813)	Yangon
June 6 (Tue)	Courtesy call to the Embassy of Japan in Myanmar Visit to the Myanmar Pulses, Beans & Sesame Seeds Merchants Association Visit to the Japanese company's local offices Visit to the sesame shippers	Yangon
June 7 (Wed)	Yangon to Nay Pyi Taw (by car) Visit to MOALI, DOA Visit to MOALI, DAR	Nay Pyi Taw
June 8 (Thu)	Nay Pyi Taw to Magway (by car) Visit to the agricultural materials shops (to collect the pesticides information) Visit to the DOA Magway office Visit to the DAR Magway farm Visit to the sesame shippers Meeting with the former DAR Magway farm manager	Magway
June 9 (Fri)	Attended the demonstration of sesame harvest in Pwintbyu T/S Visit to the Magway Chamber of Commerce and Industry Magway to Aung Lan (by car) Visit to the sesame farmers in Pyitaryar village	Aung Lan
June 10 (Sat)	Visit to the DOA Aung Lan T/S office Visit the agricultural materials shops Revisiting the DOA Aung Lan T/S office Visiting the sesame farmers in The Pu Hla village	Aung Lan
June 11 (Sun)	Visit to the beans and sesame shippers Aung Lan to Magway (by car) Visit to the DOA Magway office to report the survey results Magway to Nay Pyi Taw (by car)	Nay Pyi Taw
June 12 (Mon)	Material preparation Visit to the Yezin Agricultural University JICA project	Nay Pyi Taw
June 13 (Tue)	Visit to the DOA (Nay Pyi Taw) to report the survey results and to discuss the technical guidance contents Nay Pyi Taw to Yangon (by car) Departure from Yangon (ANA: NH814)	Night flight
June 14 (Wed)	Arrived at Narita	

1. Purpose of the Preliminary Survey

In the preliminary survey, we clarified the sesame cultivation situation, issues related to the quality and quantity to determine what technologies are needed at the field in order to achieve stable production and quality improvement. We also determined the target region and arranged for the technical guidance.

2. Survey Results

1) Sesame Cultivation Situation in Myanmar

There are three major sesame production regions in Myanmar; Mandalay, Magway and Sagaing, and more than 90% of Myanmar's sesame is produced in these regions. As the black sesame for Japan is mainly produced in Magway Region, we investigated the cultivation situation and issues mainly on the black sesame from Magway.

In Magway, many farmers had previously cultivated white sesame but shifted to black sesame cultivation as the black sesame's demand increased. The main black sesame's production area in Magway is Aung Lan T/S located in the southern part of Magway. Aung Lan is the important production area as they have been traditionally cultivating the black sesame with good quality. The reason why the black sesame production became popular in Magway Region was because Aung Lan was the famous production area.

DOA Magway regional office puts effort into the promotion of black sesame cultivation to contribute to the profitability improvement of farmers, but they consider that still there are quality issues although they have taken a lot of time on the education for farmers. For example, some farmers grow both white and black sesames causing the trouble of mixing both seeds. As the seeds production and distribution is the responsibility of DRA, strengthening of the cooperation between DOA and DAR is important.

DAR Magway farm was established in 1927 and used to be called Oilseed Crop Research Centre. They conduct seed multiplication, sales and variety qualification test. They also treat pulses other than sesame. The variety of sesame is evaluated placing importance on drought resistance, heat resistance and growing period and there are four seed multiplication target varieties, Magway 7/9, Magway 2/21, Teppan Nei (Science Black) and Samou Nei. Other than those above, Magway Nei 1/2013 is considered as a promising variety among those tested at farmer's fields. The characteristics of this variety are the shortness of growing period and goodness of color. They think that Magway Nei 1/2013 is fit for the sesame cultivation in irrigated area as it can be harvested within 80 - 85 days while that of Sinyadanar 3 and Sinyadanar 14, introduced by DAR head office in Yezin, require 90 - 95 days.

Table 2-1. Variety list of black sesame

Recommended varieties by DAR head office	Sinyadanar 3	released in 1990, with high-yield
	Sinyadanar 14	new variety, with high-yield but susceptive to the stem rot
Recommended varieties by DAR Magway farm	Magway 7/9	
	Magway 2/21	
	Teppan Nei	Nei means "black". sometimes simply called as "Teppan". also called as "Science Black". the variety has been cultivated traditionally in this area and demand from the market is high.
	Samou Nei	
	Magway Nei 1/2013	planned to be released in the future with short growing period and in shiny black

* based on the hearing of the investigating team

It is not clear, at the moment, how much these recommended varieties are cultivated as almost all of the farmers around Magway get seeds from their own harvest. It is explained that DOA office introduces DAR to the farmers who visit them to purchase the seeds but there are few farmers who actually purchase them as the prices are relatively high.

They explained that they are interested in livelihood improvement of the farmers with black sesame and want to put effort into production technology extension as the region. They are striving to solve issues cooperating with the donors such as establishing the project to recommend GAP as food safety consciousness is increasing although issue-solving, such as unit yield improvement, proper pesticides use or post-harvest processing, requires a huge amount of time due to the difficulty of thorough coaching on cultivation with the limited number of extension officers.

2) Issues raised at each supply-chain stages of black sesame export

We conducted interviews in this investigation from not only the farmers as the producer but also the relevant persons of supply chain to grasp their concerns and issues at each stage.

(1) Producers (farmers)

Agricultural productivity improvement (unit yield increase), reduction of production loss (disease and insect damage) and cost reduction (particularly, labors) and profit securement commensurate with the work efforts or costs of sesame cultivation.

(2) Collectors

Quality meeting the sesame market spec is required. Especially, uniformity of the seed-coat color, impurities contamination is an issue as it gives damage to the quality. Only four shippers are equipped with a color sorter. In addition, selection loss increases if there are many impurities. Therefore, the collectors tend to differentiate the price to the products with less impurity.

(3) Shippers and Traders

The business operators who handle the black sesame to Japan recognize that the issues are the pesticide residue and free fatty acid value. It is not possible to export to Japan as a food if either exceeds the criterion value.

The Myanmar's black sesames are highly-esteemed in Japan because of its better bright black color than those from other countries. Some Japanese business operators consider that they would like to solve the issues with black sesame produced in Myanmar even if the slightly cheaper products from other countries are available.

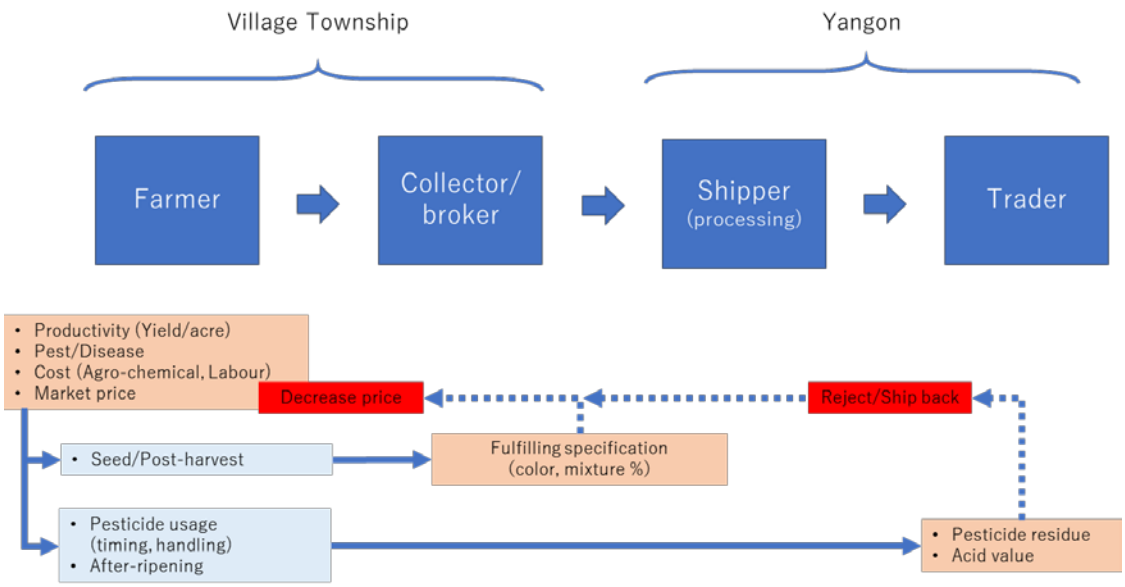

Figure 2-1. Problems at each stages of supply-chain for export sesame to Japan

3) Issues to solve in order to improve productivity and to increase farmer's income

Magway region is the production area of black sesame and many Japanese trading firms who import the sesame are buying from this region. It is necessary for sesame production promotion to stabilize the relationship with the market by stably supplying the quantity demanded by the market and fulfilling the quality sought by the market.

Following themes were discussed during the survey as issues to be tackled.

(1) Soil management

According to the soil investigation of JICA Project for Development of Water Saving Agriculture Technology in the Central Dry Zone data collection survey (2013), it became apparent that the loamy sand is dominant and the organic content amount of soil is low in the target region.

The most typical cause which impacts the yield is the presence of precipitation in the central dry zone. However, both the farmers and extension officers recognized that there are significant discrepancies in farmers' unit yield, between 5 basket (about 122.5kg) and 15 baskets (about 367.5kg) per acre in the region with the same precipitation condition and one of the reasons for this is the difference in the soils. The farmers apply the chemical fertilizer, about 1 bag (50kg)/acre as basal dressing in sesame cultivation. And some of them spray fertilizer. It was though that many farmers applied livestock manures into the fields as it is and the less compost was used.

It was considered that it was necessary to deliberate the appropriate application of chemical fertilizers by farmers in the short term and soil improvement to increase the organic matter of farmland or effective cultural improvement (rotation system or cultivation method) in the medium and long terms. Also, there is the possibility for the run-off of surface soil to become an issue as the occurrence of gully erosion on the field surface was observed at rainfall time although they have sandy soil there.

(2) Residual pesticides

(i) Use status of the pesticides

- No reply indicated that the significant problems were there when we asked about the diseases and insect damages with sesame to the farmers and government officials at the preliminary survey. It seemed that there was an excessive reliance on the pesticides as it became customary for the farmers to preventively spray pesticides 3 - 4 times during the sesame cultivation period following the instruction from the agricultural equipment shops or agrichemical companies.
- The pesticides locally used are sold at the pesticide dealers approved by the government. The pesticides used are the registered ones and use method or precaution statements are indicated following the recent approach from MOALI who supervises the pesticides trade.

<u>Pesticides use methods of the farmers</u>

Before seeding: pesticides application for the purpose of seeds disinfect

Growing period: * the farmers understand that the pesticides must be used before flowering.

Insecticide: Chloropyrifos, O,S dimethyl acetylphosphoramidothioate, Acephate, Imidacloprid etc.

Chemical herbicides (when the labor power is not available): Quizalofop-P-ethyl, Haloxyfop-R-methyl etc.
After harvest: when pilling the sesame after harvest, sometimes the insecticides are sprayed for termite control on the ground. In addition, it was told that the chemical herbicides were sprayed for after-ripening promotion (need more information to confirm).

Pesticides use by collectors or traders
During stored in the warehouse: fuming is performed every 3 months with Aluminium Phosphide in many cases.

(ii) Main pests of the sesame

The sesame diseases and insect damages in Table 2-2 became issues according to the interview at MOALI officials although we could not confirm it at the farm level in the preliminary survey. However, it seemed that they did not recognize the insect pests as a significant issue and they replied that they did not investigate to what extent they occur. It is hoped that the dispatched experts clarify whether these diseases and insect damages are actually occurred, to what extent they are serious or whether there are other countermeasures than pesticides spray.

Table 2-2. Major insect pest of sesame in Myanmar

	English name	Scientific name
Insect pest	Sesame Jassid	*Orosius albicinctus*
	Sesame Leaf Roller	*Antigastra catalaunalis*
	Cotton Bollworm	*Helicoverpa armigera*
	Death's Head Moth	*Acherontia styx*
	Common Hairy Caterpillar	*Spolosoma obliqua*
	Sesame Black Beetle	*Anomala antiqua*
	Sesame Seed Bug	*Aphanus sordidus or Elasmolomus sordidus*
Disease	Black stem	*Rhizoctonia bataticola*
	Phyllody	*Mycoplasma*
	Target spot	*Corynespora cassiicola*
	Phytophthora blight	*Phytophthora parasitica var sesami*
	Leaf spot	*Cercospora sesame*
	Fusarium wilt	*Fusarium oxysporum*
	Bacterial Leaf spot	*Pseudomonas sesami*

(iii) Challenge to the pesticide residue issues

Improvement of the pesticide treating method by the farmers (Information dissemination and edification to the farmers)

- Some sell the products mixing the rest of the seeds after adding disinfectant treatment into them.
- The pesticides contaminate the products via equipment as they use the same equipment for pesticide and for harvesting and storing.

Conduct the control in accordance with the farm condition and sesame growing situation avoiding excessive dependance on the pesticides

- The farmers do not understand the appropriate spray method swallowing the information on the sort of pesticides and number of spraying from the agrichemical company. It is necessary to control based on the actual disease and insect damage occurrence and forecasting.
- As for the post-harvest pesticide spray (at after-ripening when pilling) where detection possibility of the pesticide residue is high, it is necessary to confirm the actual status and train the farmers accordingly.

Common understanding between the relevant persons on the pesticide's appropriate use

- The agrichemical company is continuously developing the new products and promoting them by adding nourishing materials or changing the package even if the active constituent of the contents are the same. The farmers use them as recommended by the agrichemical company. This results in the cost increase.

(iv) Movement of GAP implementation

We found that there was a movement to differentiate the sales price of the products and starve off the excessive reliance on the pesticides of farmers by implementing Good Agricultural Practice (GAP) to the sesame production in Magway region. It should be considered that such movement can be linked to the export promotion of the black sesame to Japan deeply relating with the disease and insect damage control and pesticides fields of the project. We continue to try to collect the information carefully watching the GAP project movement.

(v) Other issues

We recognize that the free fatty acid value issue is caused by the post-harvest after-ripening method (pilling on the ground). The private local sesame traders (Shipper, Trader) recommend stand-drying method, but we think we need to collect information whether there are other

available after-ripening and drying methods acceptable to the farmers in the future.

Other issues we acquired through this investigation for productivity improvement are: the variety (nurturing of the varieties with high-regional-adequacy, use of superior seedlings, capsule dehiscence determinate cultivars), workload reduction (mechanization or efficient work technology), and reduction of post-harvest loss.

4) Target of the Technical Guidance

It was understood, as the result of the preliminary survey, that the productivity improvement can be expected by investigating the actual status of soil management to coach the appropriate fertilizer management as the soil management was not conducted thoroughly in sesame production and the less organic substance such as farmyard manure were applied as explained previously. We also understood that the proper use of pesticides and effective use of the pest control technology are desired as we observed the fact that the farmers rely on the pesticides while the supply chain stakeholders are deeply worried about the pesticides issues.

We decided, as a result of the discussion with the DOA Magway office, to conduct a specialized investigation and technical guidance targeting the key farmers cultivating black sesame for export focusing on Magway T/S and Pwintbyu T/S. We decided to conduct coaching proceeding with the investigation at the site by the experts in parallel as we considered that the detailed actual status confirmation by them is required to deliberate more concrete technical coaching approach in addition to the actual status clarified in the preliminary survey. We make it possible for the DOA extension officers to give instructions on investigation technology and coaching method to the farmers by conducting coaching and investigation in cooperation with them. We can expect the continual coaching effect after the project completion as the human resource development of extension officers can lead to the entire region's extension.

Chapter 3 Technical Guidance

Dispatched experts and assigned area:

Dr. Masaaki Suzuki (JAICAF Technical Advisor): soil improvement/cultivation

Dr. Azusa Fujiie (the former Director of Chiba Prefecture Agriculture and Forestry Research Center): Insect

Dr. Masahiko Kuwahara (JICAF Technical Advisor): pesticides

Dispatching period and dispatched experts:

1st. dispatch: June 21 (Wed) - June 30, 2017 (Fri) <Suzuki, Fujiie, Kuwahara>

2nd. dispatch: July 24 (Mon) - August 8, 2017 (Tue) <Suzuki, Fujiie>

Technical guidance schedule:

1st. dispatch

Date	Activity	lodging
June 21 (Wed)	Narita - Yangon (ANA: NH813)	Yangon
June 22 (Thu)	Yangon - Bago (K7 248) Bago to Magway (by car)	Magway
June 23 (Fri)	Visit to the DOA Magway regional office	Magway
June 24 (Sat)	Visit to Pwintbyu T/S	Magway
June 25 (Sun)	Visit to Pwintbyu T/S	Magway
June 26 (Mon)	Visit to Magway T/S San Ma Kyi village and Alae Bo village	Magway
June 27 (Tue)	Visit to Magway T/S Can Ywar Lay village	Magway
June 28 (Wed)	Visit to the DOA Magway regional office Magway to Nay Pyi Taw	Nay Pyi Taw
June 29 (Thu)	Visit to the DOA (Nay Pyi Taw) to report the activity results and to discuss the next coaching contents	Night flight
June 30 (Fri)	Arrived at Narita	

2nd. dispatch

Date	Activity	lodging
July 24 (Mon)	Haneda - Bangkok - Nay Pyi Taw (TG 683, PG 721)	Nay Pyi Taw
July 25 (Tue)	Visit to MOALI (DOA) Nay Pyi Taw to Magway (by car)	Magway

July 26 (Wed)	Visit to the DOA Magway regional office Visit to the agricultural materials shops	Magway
July 27 (Thu)	Visit to the farming villages (San, Magyi) Visit to the DAR Magway farm (Oil Crops Research Center)	Magway
July 28 (Fri)	Visit to Magway T/S	Magway
July 29 (Sat)	Visit to Pwintbyu T/S	Magway
July 30 (Sun)	Material preparation	Magway
July 31 (Mon)	Soil analysis at the DOA Magway offfice	Magway
August 1 (Tue)	Workshop preparation	Magway
August 2 (Wed)	Workshop preparation	Magway
August 3 (Thu)	Workshop preparation	Magway
August 4 (Fri)	Workshop at the DOA Magway regional office	Magway
August 5 (Sat)	Magway to Nay Pyi Taw	Nay Pyi Taw
August 6 (Sun)	Workshop preparation	Nay Pyi Taw
August 7 (Mon)	Workshop at DOA (Nay Pyi Taw head office) Nay Pyi Taw - Bangkok (PG 722) Departure from Bangkok (TG 642)	Night flight
August 8 (Tue)	Arrived at Narita	

I Soil

Dr. Masaaki Suzuki

1. Purpose of the activities

Investigate the soil characteristics of the sesame cultivation farmers and supervise the maintenance and management method of the soil fertility based on its results.

2. Outline of the activities

1) 1st dispatch: June 21 - June 30, 2017

We implemented the field investigation with the cooperation of the DOA Magway office for the purpose of giving the guidance on the appropriate soil management by comprehending the sesame production condition, cropping system and soil management status of the target region.

The sesame growing status was in the beginning of the harvest in Pwinbyu T/S but in the early stage of flowering in Magway T/S. This is because of the difference in water condition, the sewing time in Pwintbyu T/S, where the irrigation is available, comes faster than that of the highland on Magway T/S east bank where people have to rely on the rain water.

Firstly visiting the DOA Magway office, we heard about the issues on sesame cultivation of the region from the office chief, Mr. Khin Maung Win, and received an introduction to the persons in charge of the target region. We visited some farmer's fields located in Pwintbyu T/S along the Irrawaddy River and on the Magway highland to know the actual cultivation status of them to conduct the soil investigation and interview on the sesame cultivation management method from them. In addition, we collected the information at the agricultural material shops and DAR Magway farm in Magway.

After the investigation, we reported the outline to DOA Magway office summarizing the results and also visited DOA head office in the capital city Nay Pyi Taw to report it to the Assistant Director, Dr. Aye Ko Ko to inform that we planned to conduct the supplemental field investigation and hold workshops in Magway and Nay Pyi Taw at the next visit.

2) 2nd dispatch: July 24 - August 8, 2017

At the 2nd visit, we visited DOA head office first to meet the Director, Dr. Ye Tint Tun, to discuss the contents and schedule of the workshop which was the main purpose of this visit and asked the advice and cooperation on field investigation and workshop hosting. We determined, as the result of the meeting, to hold the 1st workshop at the DOA Magway office and 2nd workshop at DOA head office in Nay Pyi Taw. And it was also decided that we would promote the participation of the farmers other than the extension officers to the workshop in Magway as

advised by the Director.

We spent July mainly on discussion with DOA or DRA for the workshop hosting preparation and investigated/confirmed some issues we could not complete during the June visit. As for the sesame growing period, mowing was almost completed and stem and leaf disposal and rice planting had started in Pwintbyu T/S while they were in the midst of harvesting season and mowing was not finished in many farms in Magway T/S.

We spent August mainly for material preparation of the workshop and held workshop on August 4 at Magway DOA office and on August 7 at Nay Pyi Taw DOA head office. At these workshops, Suzuki, in charge of cultivation and soil fertilizer, summarized the soil management method desirable to Magway sesame cultivation and Dr. Azusa Fujiie, responsible for insect pests, summarized the ecological characteristics of insect pests and the appropriate use method of pesticides. Two representatives were assigned as the lecturers from Myanmar side as well, each from DOA and DAR, Ms. Daw Daw Win, the deputy office chief from DOA and Dr. Hla Hla Win, the farm manager from DAR. However, the lecture of Dr. Hla Hla Win was acted by Ms. Daw Maw Maw Thi in Nay Pyi Taw.

As for the OJT to the local staff, DOA research officer coached them on the investigation method and soil management method taking them to the farm investigation every day, and also explained the use method of carrying equipment to the soil research department staff and provided the soil probes, simple pH meters, EC meters, soil nutrient test kits or test reagents to the DOA local office. In addition, the equipment for pest investigation was provided.

3. Investigation method and investigation activity outline

1) Investigation method

As for the general situation of sesame cultivation in Magway, we can know the outline with the report from JICA, "Data Collection Survey on the Project for Development of Water Saving Agriculture Technology in Central Dry Zone". As the sesame cultivation area is quite extensive centering the CDZ (Central Dry Zone) and the cultivation environment, particularly soil environment significantly differs by areas, we conducted the investigation on soil management method and fertilization method limiting to the Magway region. As for the fertilizers, we conducted the interview from the agricultural material shops who deal the pesticides or fertilizers in Magway T/S. We conducted the test pit investigation up to 50cm depth and soil profile investigation using soil probes in soil investigation, and conducted water-soluble NPK measurement and judgement of pH, EC and soil texture with the soil nutrient test kit "Midorikun" using soil samples.

2) Investigation activities

We conducted the 1st investigation at 3 farms of 2 villages (Kyaung Su village and San Pya village) in Pwintbyu T/S located near the tributary on the Irrawaddy River west bank, one of the typical sesame cultivation area in Magway, and at 3 farms of 2 villages (San Ma Kyi village and Alae Bo village) in the Magway highland located on the Irrawaddy River east bank. We visited the farmers at 2nd dispatch in almost the same region as we did at 1st dispatch. This was to investigate the subsoil with the soil probe which we could not conduct last time.

As for the soil in this region, the soil in Pwintbyu T/S is the alluvial area with heavy clay soil and the sesame cropping time is earlier as the region is well watered and irrigation is possible. For this reason, the post crop of sesame is rice as a main crop and followed by the leguminous crop such as chickpea other than groundnut, i.e. three cropping seasons per year. In contrast, the soil of Magway highland is sandy loam or sandy soil greatly-differing from that of Pwintbyu T/S. As they have to rely on the rain water, the post crop of sesame is mainly groundnut and they only have 2 cultivation seasons. We conducted the observation of sesame cultivation situation and investigated the fertilization method and soil management method, particularly the treatment of cattle dung and harvest residue, and soil characteristics at all places. Several DOA staffs were also participated in the investigation activities, and the technology transfer at the site was realized.

4. Investigation results and technical guidance contents

1) Sesame cultivation situation

Magway is located in the CDZ and its annual precipitation, which is concentrated in between May and October, is 950 mm on yearly average. Sesame cultivation in Magway is conducted mainly in 2 soil zones. Pwintbyu T/S, one of them, is close to the river and irrigation is possible, and the main cropping system is three crops a year of sesame (first product of the year), rice and leguminous crop such as chickpea. Sesame is black sesame here but the high-yield cannot be hoped as broadcast sowing for seeding and dense planting are causing the tendency of low plant length, less branching and less number of pod setting. The soil is clayey and has neutral or alkaline soil texture classified into a heavy clay soil as it has high cohesiveness in the wet condition. For this reason, the water permeability is low and the soil management relying on the animal force like plowing for sesame cultivation is not easy. The sesame cultivation is almost completed during July. On the other hand, the upper part of highland is mostly sandy soil and its soil texture is classified into sandy soil or sandy loam soil. The land form is gentle but with much undulation. The black argillaceous soil, considered to be the vertisol with greatly different soil characteristics, is distributed in some places. As the crop cultivation relies on rain water with no irrigation equipment, the cropping system is two crops a year with a focus mainly on sesame and groundnut. Except for the vertisol, the agricultural work is easier due to the sandy soil but the nourishing

water retention of surface soil is quite low. In particular, the precipitation and soil moisture are the significant limiting factor of the sesame production although the sesame is relatively tolerant of dryness. Water erosion and wind erosion are the part of the soil degradation and the sesame production is susceptive to these impacts. The uneven growth seemingly caused by the water erosion or wind erosion and the windbreak hedges with the legume plants (pigeon pea or *Gliricidia sp*) were observed.

The agriculture with livestock is the main type of farm household and they raise about 4 cows per household. Some farmers are introducing large tractor but many small farmers with about 10-acre field rely on the cows for plowing or transportation.

2) Fertilization method

The fertilization methods differed by farmer (Table 3-1), compound and mixed fertilizer with urea, calcium sulfate, foliar spraying agent with trace-element were used. Fertilization was conducted using compound and mixed fertilizer as basal dressing, and urea and foliar spraying agent as top-dressing. The fertilization quantity was low, between fifth and tenth of the standard quantity in Japan although there are great differences in climate, soil or varieties. In addition, the yield was 123 - 368 kg/acre, lower compared with that of Japan of 280 - 400 kg, and had significant variability. Variability was also observed by place in the same farm. Generally, the fertilization quantity is low, especially low at sandy soil on the highland. It was explained that the reason why the fertilization quantity and method differs by farmer was because the sesame cultivation had a strong speculative factor for the farmers as the rain prediction highly-influential to sesame growth was difficult. It is considered that the azoto or potash would runoff, would limit the application effect and would not be reflected to the seedling-growth and yield of the sesame when the timing of fertilization and precipitation does not match. In addition, the symptom of iron deficiency with weeds in the farm was observed as the soil was neutral or alkaline, especially at the place where the soil pH was close to 9. Application of the calcium sulfate or foliar spraying of the trace-element was conducted in a general way and it was explained that the calcium sulfate application effects were soil pH lowering, sesame quality improvement and empty pods prevention.

Table 3-1. Examples of Fertilization of Magway farmers

farmer	Place	Fertilization method*	Use of organic matters
A	San Pya village （Pwintbyu T/S）	50kg/acre of MF (15:15:15) and 100kg/acre of Gypsum were used as BA.	Cow dung 1 ton/acre
B	San Ma Kyi village （Magway T/S）	25kg/acre of MF(15:15:15) was used as BA, and 25kg of MF(15:15:15) and	Cow dung (amount unknown)

		7.7kgN of urea were used as TD.	
C	San Ma Kyi village (Magway T/S)	29.2kg/acre of MF(15:7:8) was used as BA	FYM (amount unknown)
D	Alae Bo village (Magway T/S) ＊GAP farmer	4.4kg of N, 2kg of P_2O_5, and 2.3kg of K_2O by MF(15:7:8) were used as BA	FYM (250kg/acre)
E	Can Ywar Lay village (Magway T/S)	No fertilizer for BA, but MF(NPK+Micronutrients) was used as TD	Cow dung (amount unknown)
	Japanese farmer [3)]	32-48kg of N, 40kg of P_2O_5, 32-40kg of K_2O/acre as BA, and N:K=12kg,12kg/acre are used as TD	With or without compost

(MF: Mixed fertilizer, BA: Basal application, TD: Top dressing, FYM: Farm Yard Manure)

The livestock manure is utilized commonly to maintain the soil capabilities and the compost and barnyard manure is also produced. Establishing the barnyard manure storage space on the corner of the yard to store them in open-air state, the farmers restore them to the farm whenever required. It is said that the production of compost and barnyard manure is not easy as they have less water on the highland. For this reason, although the farmyard manure of EM 'Bokashi' (EM fermented component) was produced in some area, still many farmers scatter dried livestock manures. The utilization of harvest residue as the material of compost is not very common. The stems of sesame are burned up at farms and stems and leaves of groundnut are used for livestock feed. The rice straws are used for livestock feed. The weeds are also not utilized for compost as they are used for feeding stuff. It seems that the application quantity of compost by farmer is difficult to comprehend in many cases but it plays a significant role for retention and supply of the fertilizer components. The sesame harvest residue is burned up at such a place where they can easily secure the water like Pwintbyu T/S but it is possible to compost it by accumulating with cattle dung. The composting technology is already extended to some farmers, but it seemed that more encouragement and extension effort is necessary.

3) Planting density

In Pwintbyu T/S, the broadcast sowing and dense planting methods were employed. Although they employed the broadcast sowing method at Magway highland, they thinned it for the double purpose of weeding by making furrows of 10 - 15 cm x 35 cm lengthwise and crosswise by a grooving tool with about 15 cm teeth intervals pulled by cows after establishment. The density was 76,000 - 114,000 per acre and a little bit higher compared with Japan of 60,000 - 88,000. It

has to be deliberated at the test station whether the planting density has an impact on the quality improvement and yield increase.

4) Soil characteristics

We acquired the information with soil probes. Also we tried simple analysis of the soil sampling to detect kalium but almost no azoto seemingly because of the harvest period. As for the phosphoric acid, apparent accumulation was recognized for both Pwintbyu T/S and Magway T/S (Table 3-2). It was explained that DOA understood this accumulation tendency as well. As the soil texture of Pwintbyu T/S was heavy clay soil from surface soil to subsoil, it was thought that the vertical movement of water is small. On the other hand, Magway T/S highland is generally sandy and sandy soil was accumulated more than 1 m in many cases and it turned to SL due to the increased clay in subsoil at some places. The pH of surface soil in Pwintbyu T/S was 7.5 - 8.5 and that in Magway T/S was 6.9 - 8.4, both were between neutral and alkaline, and there was the possibility of occurring minor element deficiency, such as iron or zinc, if the conditions are accumulated. EC was 0.1 - 0.2 and not at the level damaging the crops.

As the result of subsoil characteristics investigation at selected places where the crops grew well or poorly in the same farm of Can Ywar Lay village, we found that the content amount of clay were different by depth. That is, the appearance position of the sandy loam soil (SL) or the clay loam soil (CL) was relatively shallow where the crops grew well and deep where the crops grew poorly. It was inferred that there was the possibility for the amount of clay content which had an impact on the retention and movement of water and soil nutrient gave an impact on the sesame growth due to the different sand accumulation condition by place in the farm.

Table 3-2. Soil Characteristics of sesame farmers' plots

Sample No	Location	Depth of soil (cm)	Soil moisture	Soil texture	pH (H_2O)	EC (mS)	NO_3-N ppm	P_2O_5 ppm	K_2O ppm	Stage & growth
1	Pwintbyu TS, Kyaung Su village-1	0-30	Wet	HC	8.5	0.20	0	33	<3	Harvest Poor
2	Pwintbyu TS, San Pya village-2	0-30	Wet	HC	7.5	0.12	0	33	<3	Harvest Poor
3	Pwintbyu San Pya village-3	0-20 20-40 40-50	Wet Wet Wet	HC HC HC	8.1 8.1 8.2	0.10 0.10 0.10	0 0 0	33 33 33	<3 7 7	Harvest Poor
4-1	Magway San Ma Kyi village	0-30 30-60 60-90	Dry Moist Moist	S S S	8.4 8.2 8.2	0.10 0.00 0.00	0 0 0	33 33 33	<3 <3 <3	Flower Good
4-2	Magway San Ma Kyi village	0-30 30-60 -------	Moist Moist +Mn Con.	S S	8.2 8.1	0.00 0.10	0 0	33 33	<3 <3	Flower Poor
5	Magway San Ma Kyi village	0-20	Dry	HC	8.4	0.20	0	33	<3	Vertisol Flower Poor
6	Magway Alae Bo village	0-30 30-60 60-90	Moist Moist Moist	S S S	6.9 6.8 6.8	0.00 0.00 0.00	0 0 0	33 33 33	7 7 7	GAP Harvest Good
7-1	Magway- Can Ywar Lay village	0-20 20-40 40-60 60-80	Moist Moist Moist wet	S S SL CL	7.2 7.1 6.8 6.7	0.10 0.10 0.10 0.10	0 0 0 0	33 33 33 17	<3 <3 <3 <3	HarvestGood
7-2	Magway- Can Ywar Lay village	0-20 20-40 40-60 60-80	Moist Moist Moist Moist	S S S SL	7.2 7.2 7.1 6.5	0.10 0.10 0.00 0.00	0 0 0 0	33 33 33 33	<3 <3 <3 <3	Harvest Poor
8	Magway- DAR	0-30 30-50	Dry Moist	S S	7.7 7.3	0.20 0.10	0 0	33 33	7 <3	Before harvest

As mentioned above, in the Magway region located in the central dry zone (CDZ), the sesame, particularly black sesame, is produced under the unstable weather condition and different soil characteristics.

For this reason, the different soil management method and fertilization method are sought according to each soil characteristics for the stable production of sesame. Although this investigation was conducted in the short period and the investigation scope was not broad enough, we got the following conclusions based on the investigation results. That is, in case of the argillaceous soil, the fertilization can be conducted with an emphasis on the basal dressing as it has the strong nutrition retention power and less fertilizer runoff. However, in case of the sandy soil to subsoil, the runoff of the nutrient element by eluviation is concerned as the nourishing water's retention power is weak.

For this reason, it is assumed more effective to apply in several batches with an emphasis on top-dressing reducing the basal dressing to a half. We supposed that the production power of soil is affected by the soil texture of subsoil observed in the soil profile.

Sesame is the export crop and especially the black sesame is the directly consumed food. Therefore, it is important to develop the cultivation technology to produce safe and high-quality sesames and the quality management technology.

5. Coaching contents and dissemination activities

1) Technologies coached

We coached the technologies required for the investigation to the DOA staffs accompanied to the investigation through OJT. The concrete contents were 3 points following.

- soil investigation with soil probe and attitude to a field investigation
- use method of soil test kit
- suggestion of fertilization method according to the soil characteristics

We instructed the fertilization method according to the soil characteristics to the key farmers and conducted follow-up by inviting them to the workshop.

It is required to popularize the standard cultivation technologies and soil management technologies in the future and the thorough recording practice of cultivation (from seeding to harvest/sales) by the farmers is also necessary.

2) Outline of the Workshop

Sixty people from the farm households, agriculture extension officers, public administrations, research related persons, JICA the "Project for Profitable Irrigated Agriculture in Western Bago Region (PROFIA)" project and International Trade Center (ITC) were participated in the workshop. In the DOA's lecture, sesame production and pests issues including coping methods

with pesticides, acid value increase by drying method, soil conservation handling methods against the soil denudation by precipitation and wind erosion, introduction of the technical course on composting for the harvest residue of crops including sesame and characteristics of chemical fertilizers were explained. And, in DAR's lecture, nurturing of the new sesame variety and characteristics, and its production status for distribution were introduced. As for the soil management, Suzuki explained the issues in production and made a proposal on improvement methods of fertilization method based on the soil investigation of the typical sesame cultivation farm in Magway. And, Dr. Fujiie, in charge of insect pests, introduced investigation method of sesame pests, inhabiting situation of the major pests and natural enemies, pest control method, applying pesticides in Myanmar and Japan, biological agrochemicals and IPM method based on the investigation conducted twice at the farm site and proposed the countermeasure technology against the sesame's disease and insect damage explaining the occurrence status of them in Myanmar from early stage of growth to post-mowing deposition time of sesame.

We put these lecture contents in print as the information to distribute as an educational material not only to the farmers and extension officers involved in the sesame production but also to the administrative staffs or researchers. After the lectures, the interest was shown on how they could sell at the Japanese market, distribution system or mechanism of pesticide residue occurrence from the participants including the farmers.

At the workshop in Nay Pyi Taw, the lecture was conducted based on the same material but 28 persons attended from DOA staffs and JICA human resource development project of Yezin Agricultural University. We were promoted to discuss thoroughly on safe use of the pesticides and fertilizers and on GAP by the DOA Director and there were the comments from Assistant Director and Magway regional office chief in the discussion after the lecture. The Assistant Director pointed out that the important issue in Magway is the pesticide use and emphasized that the pesticide issue is not its post-harvest use for Stink bugs control but rather the fact that the farmers did not fully understand the proper use. The sesame production accounts for 40% of the country's gross agricultural production and 100 kt out of its total production quantity of 200 kt was exported. He wanted to head for even better cultivation as Magway had implemented the system from production to export. It is important for the administrative agency to implement the soil conservation cooperating with the farmers. They have many sesame pesticides in Myanmar, and he wanted to properly instruct its use and fertilization technology. He wanted to promote the safe sesame production and export in accordance with GAP guideline. In addition, the office chief of Magway regional office stated several ambitions on research subjects. They are: 1. the relation between use of fertilizer and corresponding revenue; 2. clarification of the roll of farm subsoil for sesame growth; 3. development of the effective utilization technology of the sesame selection residue; 4. development of the good-quality sesame cultivation technology with traditional

pesticides; - and so on. In addition, he explained that the small-sized brokers have issues of mixture of quality goods and defective goods, or in seedlings processing method. He instructed to limit the farmers' accumulation period at farm after harvest to 2 days. He wanted to deliberate the pesticide residue issues. Currently, they have Serena-13 and -14 as superior varieties and started to export them. And, they cultivate at 3,000 acre in accordance with GAP guideline, - and so on.

Besides these, the DRA variety developer explained that they are conducting Serena varieties cultivation method inquest, seed multiplication and coaching the fertilization guideline to the farmers. In addition, Prof. Saito at Yezin Agricultural University commented on significance of fertilizer test and importance of target quantity setting. The reply to this was that the fertilization and irrigation were necessary in practice as the yield of sesame cultivation was governed largely by the precipitation condition although they were targeting at 1.2 ton per ha.

As mentioned above, the workshop was extremely useful as the information sharing opportunity for the relevant persons.

3) Manual preparation

We held the workshop at DOA Magway regional office, the sesame cultivation sites, and DOA head office in the capital city, Nay Pyi Taw. The lecture contents was put the PowerPoint script in print to distribute to the participants and the discussion was conducted for manual preparation. The manual was made up reflecting the comments at workshops. The manual is consists of 2 types, "Compost making" and "Soil management method for sesame cultivation in Magway", and each has 2 versions for the extension officers, the summarized version to easily bring to the sites and the expository version to explain the detailed contents.

6. Challenges for the future and some suggestions

Although this investigation had to be completed in a short period, we could understand the typical soil around Magway T/S to implement the technical guidance as we could investigate twice in flowering period and harvest period. However, we could not refer to Myanmar in its entirety. In addition, we think that MOALI has to investigate the following to establish appripriate cultivation technology of sesame and improve its productivity and quality.

- Survey of the current situation of top-dressing and effect evaluation
- Survey of the current situation of foliar spraying and effect evaluation
- Survey of the current situation of the compost making/application and effect evaluation
- Impact clarification of pilling of harvested sesame to its quality
- Analysis of the GAP farmer information, clarification of the relation between fertilization method or precipitation and yield

- Clarification of the growth difference at the same farm of a farmer
- Actual cultivation status analysis of the excellent farmers
- Sesame production issue clarification in cooperation with DAR and DOA
- Actual status clarification of nutrition and water movement in the soil layer
- Development of fertilization method and soil management method according to the soil characteristics

It is considered that the important objective for Myanmar black sesame production is to establish the high-quality/stable/high-yield cultivation method for the future based on the investigation/research above.

7. Reference Materials

(1) JICA and Sanyu Consultants Inc. (2013) Data Collection Survey on the Project for Development of Water Saving Agricultural Technology in the Central Dry Zone in the Republic of the Union of Myanmar - Final report to the Ministry of Agriculture and Irrigation, The Republic of the Union of Myanmar, pp.120.

(2) Land Use Division, Ministry of Agriculture and Irrigation, (year unidentified) Soil types and characteristics of Myanmar: pp.38.

(3) Masumi Katsta (2002) Origin and characteristics of sesame, Basic technology of cultivation, Agricultural technology basic edition Vol. 7 Addendum No. 24: 1-17.

II Insects Pest

Dr. Azusa Fujiie

1. Purpose of the activities

The following 3 items are set as the goal of this project in the project proposal.

① to give guidance on the appropriate soil management by comprehending the sesame production condition, cropping system and soil management status of the target region.

② to give guidance on more effective pest control methods by comprehending the occurrence situation of insect pests and their control method of the target region.

③ to give guidance on the appropriate pesticides use methods by comprehending their status of use in the target region.

And thus, to respond to ②, we investigate the insect pest occurrence status of sesame in Myanmar to deliberate the appropriate control method for the main insect pests. In addition, we will conduct the information collection through literatures and interviews. We contribute to the advancement of sesame cultivation by sharing the acquired perception and information with the relevant persons of Myanmar (public administrations, researchers, extension officers, farmers). As the results of this, we contribute to the activities of Japanese agriculture and food related enterprises by making it possible for them to supply the agricultural products (sesame) with the quality demanded by the Japanese enterprises.

2. Activity period

We conducted our activities in Magway Region, a sesame production area located in the central dry zone of Myanmar, during June 21 - June 30 (the first dispatch) and July 24 - August 8, 2017 (the second dispatch).

3. Activity results

1) Activity Background

Sesame (pronunciation: 'sɛsəmi', binomial name: Sesamum indicum) is an annual crop classified into Order: Lamiales, Family: Pedaliaceae Genus: Sesamum). The seeds of sesame contain a lot of oil and fat content. Lignans (sesamin or sesamolin) contained in the sesame seedlings have many functionalities, such as antioxidative property (prevent the actions of active oxygen), cholesterol absorption/cholesterol synthesis inhibition effect, transaminase (GOT, GTP) activity improvement effect (Yasumoto, 2008). The high-functionality of sesame is received widespread attention in increase of worldwide health consciousness.

The main industry of Myanmar is the agriculture and the agricultural products are the important export items (MOFA HP, Ministry of Agriculture, Forestry and Fisheries of Japan HP) ; rice, sugar

cane, cotton, corn, sunflower, pulses and sesame are the main agricultural products (JICA and Sanyo Consulting Inc., 2013). They are cultivating rice in the delta zone and pulses and sesames in the central dry zone as the main crops. As the sesame, with groundnut or sunflower, is important as the food for domestic consumption and also as the export agricultural product, the expansion of the crop acreage and improvement of the productivity and quality are being promoted. Sesame is mainly consumed as food oil, and it essential for food culture in Myanmar. When we visited Myanmar, we can realize that they use sesame oil very often. And, the sesame export quantity is large following pulses and rice.

As sesame is relatively tolerant of heat or dryness and regarded as an easy crop to cultivate, it is cultivated from tropical regions to semitropical regions in Asia, Africa and South America. In Magway T/S located in the center of the central dry zone, main sesame production area in Myanmar, the average temperature is 21.0ºC and the annual precipitation is 940 mm, i.e. the temperature is relatively high and the precipitation is low. (Kikuchi and others) Just for reference, 27.4ºC and 2,108 mm in the former capital Yangon located in the delta zone and 15.4ºC and 1,529 mm in Tokyo (Meteorological Agency HP). In the central dry zone, they are sometimes suffering from droughts and the cultivation is extensive as many farm lands have no irrigation facility and rely on the rain water. However, in Magway Region where we conducted the investigation, the management works, such as pesticides spraying, fertilization and weeding, were conducted. The sesame famers have great concerns with insect pest damages and therefore some of them are using inappropriate chemical pesticides.

Supporting the statement above, the case where the imidacloprid (neonicotinoid insecticide) was detected from the sesame exported to Japan from Myanmar with higher level than the standard of 0.01 ppm. Imidacloprid is sold in Japan under the tradename of ADMIRE but cannot be used as sesame is not an applicable crop. Neonicotinoid insecticide, other component part than imidacloprid, is also widely distributed under the various tradenames, such as Mospiran, Bestguard, Bariard, Akutara, Dantotsu or Starkl but it is not used for sesame. As sesame is a minor crop with limited growing area, registered pesticides are also limited.

In sesame production, the proper cultivation management is required to target high-quality and high-yield and the various countermeasures against the insect pests are also required. The control method using pesticide (insecticide) is effective as one of the various control measures. The cultivation method without relying on any chemical pesticides (organic agriculture) is not impossible but we should not exclude the chemical pesticides if we target high-quality and high-yield. However, the excessive dependence on chemical pesticides should be strictly refrained in increase of worldwide momentum for food safety and security intention or for environmental consideration. In Myanmar's sesame cultivation, the full attention should be payed to the issues that pesticides have such as pesticide residue issue as export agricultural products and also as

domestic consuming food. In addition, the appropriate response to the pesticides agrees with GAP (Good Agricultural Practice) spirit Myanmar is promoting. Proper use of the proper pesticides is important based on Myanmar's laws and regulations.

In this project, we investigated the pest occurrence situation of sesame in Myanmar to deliberate the appropriate control method for the main insect pests. In addition, we conducted interviews and collection of literature information (refer to the Background Materials). We summarized our activity results here based on these information.

2) Investigation spots and activity contents

In Myanmar, sesame is mainly cultivated in the central dry zone (Magway Region, Mandalay Region and Sagaing Region). We conducted the investigation at the sesame farms of Magway Township, Magway District and Pwintbyu Township, Minbu District in Magway region this time. Investigation points are as indicated in Table 3-3 and Table 3-4. We conducted the investigation on insect pests and natural enemies at the sesame farms and the peripheral areas with weed: at the 1st dispatch, from the earlier period of cultivation (seeding period - flower bud formation period) to the dry period, and at the 2nd dispatch, from the latter period of cultivation (blooming period - harvest period) to the dry period.

In addition we collected the information from the Ministry of Agriculture, Livestock and Irrigation - DOA, Head office; DOA Magway office; the Ministry of Agriculture, Livestock and Irrigation - DAR Magway farm (the former Fat and Oil Seed Crops Research center), the sesame farms and the pesticide dealers. We also collected the literature information.

At the 2nd dispatch, we held the workshop (for the famers, DOA and DRA) in Magway and Nay Pyi Taw for technology transfer and information sharing. At the workshop, the topics were exchanged providing the soil fertilizer and pests related subjects from DOA, the variety related subjects from DAR and the soil fertilizer and pests related subjects from Japan.

Table 3-3. Investigation points of sesame insect pests and natural enemies in Myanmar (June, 2017)

Abbr.	Point-name	Date	Remarks
#1	Kyan Su Village, Pwintbyu TS	24-Jun	In drying (stand) in the outside of a field. Sesame investigation
#2	Kyan Su Village, Pwintbyu TS	24-Jun	In sesame cultivation. Sesame and weeds investigations
#3	Kyan Su Village, Pwintbyu TS	24-Jun	In field drying (stand). Sesame and weeds investigations
#4	San Pya Village, Pwintbyu TS	24-Jun	In sesame cultivation. Sesame and weeds investigations. Yellow sticky traps
#5	San Pya Village, Pwintbyu TS	24-Jun	In field drying (pile). Seed investigation. Yellow sticky traps
#6	San Pya Village, Pwintbyu TS	24-Jun	In sesame cultivation. Sesame and weeds investigations
#7	San Pya Village, Pwintbyu TS	24-Jun	In sesame cultivation. Sesame and weeds investigations
#8	San Magyi Village, Magway TS	25-Jun	In sesame cultivation. Early stage. Sesame investigations
#9	San Magyi Village, Magway TS	25-Jun	In sesame cultivation. Sesame investigations
#10	San Magyi Village, Magway TS	25-Jun	In sesame cultivation. Sesame and weeds investigations
#11	San Magyi Village, Magway TS	25-Jun	In sesame cultivation. Sesame and weeds investigations
#12	Aloe Bo Village, Magway TS	25-Jun	In sesame cultivation. Eary stage. Sesame investigations
#13	Aloe Bo Village, Magway TS	25-Jun	In sesame cultivation. Sesame investigations
#14	San Pya Village, Pwintbyu TS	26-Jun	In sesame cultivation. Sesame investigations
#15	San Pya Village, Pwintbyu TS	26-Jun	In field drying (pile). Sesami investigation
#16	San Pya Village, Pwintbyu TS	26-Jun	In sesame cultivation. Sesame investigations
#17	Con Ywor Lay Village, Magway TS	27-Jun	In sesame cultivation. Eary stage. Sesame and weeds investigations
#18	Con Ywor Lay Village, Magway TS	27-Jun	In sesame cultivation. Sesame investigations
#19	Con Ywor Lay Village, Magway TS	27-Jun	In sesame cultivation. Sesame investigations
#20	Con Ywor Lay Village, Magway TS	27-Jun	In sesame cultivation. Eary stage. Sesame and weeds investigations

Table 3-4. Investigation points of sesame in Myanmar (July, 2017)

Abbr.	Point-name	Date	Remarks
#1	San Magyi Village, Magway TS	27-Jul	In sesame cultivation. Sesame and weeds investigations
#2	San Magyi Village, Magway TS	27-Jul	In sesame cultivation. Sesame and weeds investigations
#3	San Magyi Village, Magway TS	27-Jul	In sesame cultivation. Sesame investigations
#4	San Magyi Village, Magway TS	27-Jul	In sesame cultivation. Sesame and weeds investigations
#5	San Magyi Village, Magway TS	27-Jul	In sesame cultivation. Sesame and weeds investigations
#6	Aloe Bo Village, Magway TS	27-Jul	In sesame cultivation. Sesame investigations
#7	Aloe Bo Village, Magway TS	27-Jul	In sesame cultivation. Sesame investigations
#8	Aloe Bo Village, Magway TS	27-Jul	In field drying (stand). Sesame and weeds investigations
#9	CanYwor Lay Village, Magway TS	28-Jul	In sesame cultivation. Sesame investigations. Yellow sticky traps
#10	CanYwor Lay Village, Magway TS	28-Jul	In sesame cultivation. Sesame investigations. Yellow sticky traps
#11	CanYwor Lay Village, Magway TS	28-Jul	In sesame cultivation. Sesame and weeds investigations
#12	CanYwor Lay Village, Magway TS	28-Jul	In sesame cultivation. Sesame investigations
#13	CanYwor Lay Village, Magway TS	28-Jul	In sesame cultivation. Sesame investigations
#14	CanYwor Lay Village, Magway TS	28-Jul	In sesame cultivation. Sesame investigations
#15	CanYwor Lay Village, Magway TS	28-Jul	In sesame cultivation. Sesame investigations
#16	San Pya Village, Pwintpyu TS	28-Jul	In sesame cultivation. Sesame investigations. Yellow sticky traps
#17	San Pya Village, Pwintpyu TS	28-Jul	In sesame cultivation. Sesame investigations. Yellow sticky traps
#18	San Pya Village, Pwintpyu TS	28-Jul	In field drying (pile). Seed investigation
#19	San Pya Village, Pwintpyu TS	28-Jul	In sesame cultivation. Sesame investigations
#20	San Pya Village, Pwintpyu TS	28-Jul	In sesame cultivation. Sesame investigations

3) Investigation method of sesame pests and natural enemies

The various investigation methods can be considered when investigating the actual occurrence status of insect pests and natural enemies for sesame and peripheral weeds. Both scooping method and direct counting method is applied to the sesame during cultivation, direct counting method to those during drying and scooping method to the weeds in Myanmar. In addition, we set the yellow sticky traps in the farms.

(1) Scooping method

At each farm and peripheral weeds, we made 20-swngs (10 back-and-forth motions) with the insect nets of 36 cm in diameter. We brought back the insects captured putting in the plastic bags, froze to death, and recorded the number of individuals selecting the pests and natural enemies.

(2) Direct counting method

We investigated the number of the larva of Scarabs digging the root targeting 5 stocks at each farm. In addition, we investigated the number of pathopoiesis stumps. We recorded the number of pests and natural enemies of sesames during drying by observing for 5 minutes.

(3) Sticky trap method

We recorded the number of the insect pests and natural enemies by species stuck to the yellow sticky traps (width: 10 cm and length: 30 cm).

4) Sesame pest occurrence situation

Aphids, Sphinx moths, Stink bugs, Gryllotalpidae or Nematodes are known in Japan (The Japanese Society of Applied Entomology and Zoology, 2006). Scarabs, Owlet moths (Cutworms) or Tarsonemidae may be generated as well. Spodoptera litura and Agrotis segetum are the major insect pests in Kikai-ga-jima of Kagoshima prefecture, only one large scale sesame production area in Japan (about 100 ha). We conducted our investigation at the sesame farms and peripheral land with weeds to clarify the sesame insect pest occurrence situation. As the results of that, we confirmed the pest occurrence status as follows.

(1) Sesame insect survey result

Investigation result of sesame insects are as indicated in Table 3-5 and Table 3-6. Occurrence of Leafhoppers, Stink bugs, Scarabs, Pyralid moths, Tiger moths and Owlet moths (Cutworms) were confirmed. Nematodes might occur according to the information from the farmers.

In June, we observed phytoplasma-infected (called MLO in past days) farms (#5, #10, #13, #14, and #19) by *Orosius albicinctus*, a variety of Leafhoppers, with their cultivating sesame. In July,

we observed the occurrence at furthermore farms (#1 - 7, #9 - 17, #19 and #20) including a farm with intense outbreaks (#14, the parasitized stock rate of 47%). It was assumed that the significant yield decrease was occurring as the pathopoiesis stumps reduce the number of pod settings or stopped pod setting. It was assumed that the sesames were infected during their cultivation former period by Leafhoppers but they were observed not only with them but also with those in the cultivation latter period. They were captured with the yellow sticky trap as well. The occurrences of the Leafhoppers were observed in many farms, but it seemed not to be a plague. However, it is necessary to take deliberate countermeasures as it is considered that the vector has high capability in phytoplasma transmission.

Table 3-5. Sesami insect pests on sesame in Myanmar (Sweeping method and direct counting method, June, 2017)

Abbr.	Aphididae	Cicadellidae	Pentatomidae Pyrrhocoridae Lygaeidae	Scarababidae	Pyralidae	Sphingidae	Arcitiidae	Noctuidae budworms, cutworms, etc.	Other	Remarks
#1	0	0	4	0	0	0	0	2	0	Direct
#2	0	0	2	0	0	0	0	0	0	Sweeping
#3	0	5	0	0	0	0	0	0	0	Sweeping
#4	0	0	0	0	0	0	1	0	0	Swepping
#5	0	0 (MLO 1%)	1	0	0	0	0	0	0	Direct
#6	0	3	0	0	0	0	0	0	0	Sweeping
#7	0	2	1	0	0	0	0	0	0	Sweeping
#8	0 (Virus 3%)	5	1	2	2	0	0	0	0	Sweeping
#9	0	0	0	0	1	0	0	0	0	Sweeping
#10	0 (Virus 4%)	0 (MLO 14%)	2	0	0	0	0	0	0	Swepping
#11	0	0	1	0	0	0	0	0	0	Sweeping
#12	0	0	0	0	0	0	0	0	0	Sweeping
#13	0 (Virus 2%)	1 (MLO 15%)	0	8	0	0	0	0	0	Swepping
#14	0	7 (MLO 1%)	1	0	0	0	0	0	0	Sweeping
#15	0	0	0	0	0	0	1	0	0	Direct
#16	0	0	0	0	0	0	0	0	0	Sweeping
#17	0	3	1	0	0	0	0	0	0	Sweeping
#18	0	3	0	0	0	0	0	0	0	Sweeping
#19	0	1 (MLO 1%)	0	0	0	0	0	0	0	Sweeping
#20	0	1	1	0	0	0	0	0	0	Sweeping
#4 Y trap	0	3	0							
#4 Y trap	0	7	0							
#5 Y trap	0	10	0							
#5 Y trap	0	11	0							

Note 1: Sweepimgs were carrid out 20 times with an insect net (36 cm in diameter) in each point.
Note 2: In direct counting method, the individual number is indicated as total numbers.
Note 3: Yellow sticy traps (Y traps: 20 × 10cm) were set for three days in #4 and #5.
Note 4: MLO (Mycoplasma-liked organism) is called Phytoplasma.

Table 3-6. Sesami insect pests on sesame in Myanmar (Sweeping method and direct counting method, July, 2017)

Abbr.	Aphididae	Cicadellidae	Pentatomidae Pyrrhocoridae Lygaeidae	Scarababidae	Pyralidae	Sphingidae	Arcitiidae	Noctuidae budworms, cutworms, etc	Remarks
#1	0 (Virus 1%)	6(MLO 11%)	1	0	0	0	0	0	Sweeping
#2	0 (0%)	7(MLO 9%)	0	0	0	0	0	0	Sweeping
#3	0 (0%)	3(MLO 5%)	0	0	0	0	0	1	Sweeping
#4	0 (0%)	3(MLO 7%)	0	0	0	0	0	0	Sweeping
#5	0 (0%)	2(MLO 2%)	0	0	0	0	0	0	Sweeping
#6	0 (0%)	4(MLO 8%)	0	0	0	0	0	0	Sweeping
#7	0 (Virus 1%)	0(MLO 3%)	6	0	0	0	0	0	Sweeping
#8	0	0	0	0	0	0	0	0	Direct
#9	0 (0%)	2(MLO 10%)	0	0	0	0	0	0	Sweeping
#10	0 (0%)	0(MLO 41%)	0	0	0	0	0	0	Sweeping
#11	0 (Virus 1%)	1(MLO 10%)	1	0	0	0	0	0	Sweeping
#12	0 (0%)	1(MLO 8%)	0	0	0	0	0	0	Sweeping
#13	0 (0%)	0(MLO 4%)	0	0	0	0	0	0	Sweeping
#14	0 (0%)	1(MLO 47%)	2	0	0	0	0	0	Sweeping
#15	0 (0%)	1(MLO 3%)	0	0	0	0	0	0	Sweeping
#16	0 (0%)	1(MLO 33%)	1	0	0	0	0	0	Sweeping
#17	0 (0%)	0(MLO 25%)	0	0	0	0	0	0	Sweeping
#18	0	0	0	0	0	0	0	0	Direct
#19	0 (0%)	(MLO 0%)	4	0	0	0	0	0	Sweeping
#20	0 (0%)	(MLO 0%)	1	0	0	0	0	0	Sweeping
#10 Y trap	0	17	0						
#12 Y trap	0	6	0						
#16 Y trap	0	2	0						
#17 Y trap	0	1	1						

Note: Yellow sticy traps (Y traps: 20 × 10cm) were set for two days in #10, #12, #16 and #17.

The occurrence of virus disease was observed. Although the number of farms with virus disease were less than those of phytoplasma, it could cause of the extreme yield decrease as sesame will stop pod setting when virus disease occurs. Although it seems that virus disease is transmitted mainly by Aphids, we could not confirm them on the sesame plant body in this investigation period. We could not capture Aphids even with the yellow sticky trap which attracts Aphids. As we have less perception information on virus disease for sesame, it seems necessary to clarify its transmission method, such as an existence of other varieties of vectors or contact infection. The significant damage would be caused if they have a huge outbreak of Pyralid moths, Tiger moths or Owlet moths (Cutworms), but the density was low in this investigation. Rhizoctonia disease was observed in the cultivation latter period other than phytoplasma disease and the virus disease.

Stink bugs or Tiger moths were found with the sesame during the drying at post-harvest farms. The damage at this time is not very clear, but it is considered not to be significant. In any case, use of the insecticides should be avoided from the view point of pesticide residue countermeasure at this stage. The net covering is effective against Stink bugs.

Stink bugs or Tiger moths were found with the sesame during the drying at post-harvest farms. It is told that Termitidae also gives the damages. Use of the insecticides should be avoided to get away from the pesticide residue issue even if the pests were occurring during the drying period. Therefore, it is not recommendable to dry it at farms from the view point of pest issues. Furthermore, it is also pointed out that drying at the farms lowers the quality of sesame.

(2) Investigation result on the pests of weeds

Investigation result of the peripheral weeds around sesame farms are as indicated in Table 3-7 and Table 3-8. Leafhoppers, Stink bugs, Sphinx moths and Owlet moths were detected, and they were thought as the sesame pests. Many Leafhoppers occurred in peripheral weeds, and it is supposed that they are involved in the phytoplasma transmission.

(3) Outline of Myanmar's sesame pests

The biology of sesame main insect pests confirmed in the investigation of the sesame and peripheral weeds are as follows (Crop protection branch, 1999; Toshihiko Sato, Syuichi Yamashita, Yasuo Honma, 2001; NARO Bio-oriented Technology Research Organization, 2006).

Table 3-7. Sesami insect pests on weeds in Myanmar (Sweeping method, June, 2017)

Abbr.	Aphididae	Cicadellidae	Pentatomidae Pyrrhocoridae Lygaeidae	Scarababidae	Pyralidae	Sphingidae	Arcitiidae	Noctuidae budworms, cutworms, etc.	Other	Remarks
#1	Un-investigation									
#2	0	4	0	0	0	0	0	0	0	
#3	0	3	0	0	0	0	0	0	0	
#4	0	0	3	0	0	0	0	0	0	
#5	Un-investigation									
#6	0	3	2	0	0	0	0	0	0	
#7	0	0	0	0	0	0	0	0	0	
#8	Un-investigation									
#9	Un-investigation									
#10	0	0	0	0	0	0	0	0	0	
#11	0	2	0	0	0	0	0	0	0	
#12	Un-investigation									
#13	Un-investigation									
#14	Un-investigation									
#15	Un-investigation									
#16	Un-investigation									
#17	0	0	0	0	0	0	0	0	0	
#18	Un-investigation									
#19	Un-investigation									
#20	0	8	2	0	0	0	0	0	0	

Table 3-8. Sesami insect pests on weeds in Myanmar (Sweeping method, July, 2017)

Abbr.	Aphididae	Cicadellidae	Pentatomidae Pyrrhocoridae Lygaeidae	Scarababidae	Pyralidae	Sphingidae	Arcitiidae	Noctuidae budworms, cutworms, etc.	Remarks
#1	0	1	1	0	0	1	0	3	
#2	0	2	0	0	0	0	0	0	
#3	Un-investigation								
#4		1	0	0	0	0	0	0	
#5	0	0	0	0	0	0	0	0	
#6	Un-investigation								
#7	Un-investigation								
#8	0	3	1	0	0	0	0	0	
#9	Un-investigation								
#10	Un-investigation								
#11	0	0	2	0	0	0	0	0	
#12	Un-investigation								
#13	Un-investigation								
#14	Un-investigation								
#15	Un-investigation								
#16	Un-investigation								
#17	Un-investigation								
#18	Un-investigation								
#19	Un-investigation								
#20	0	0	1	0	0	0	0	0	

(i) Aphids (family: Aphididae)

Peach-potato aphid (family: *Myzus persicae*), Glasshouse-potato aphid (family: *Aulacorthum solani*): we could not detect Aphids but confirmed the virus disease with sesame in Myanmar. It is thought that it is transmitted by Aphids, but the detailed relation between Aphids and the virus disease to sesame is not very clear. It is inferred that Peach-potato aphid is found in sesame of Myanmar. One hundred ninety nine species, out of the insects belongs to Aphididae, so-called Aphids, are known as the pests (The Japanese Society of Applied Entomology and Zoology, 2006). Among many Aphids, Peach-potato aphid and Glasshouse-potato aphid are widely observed globally and attack many agricultural products. They are troublesome pests. They not only suck the agricultural products but also transmit the virus disease.

(ii) Leafhoppers (family: Cicadellidae)

Sesamum jassid, a kind of Spotted leafhopper (family: *Orosius albicinctus*): the phytoplasma disease is breaking out at sesame farms in Myanmar. The details are not clarified yet, but the vectors seem to be this species. In Japan, *Recilia (Inazuma) dorsalis* and *Orosius orientalis inhabit and it is known that they are transmitting phytoplasma to rice or vegetables.*

(iii) Stink bugs (family: Pentatomidae), Pyrrhocorid bugs (family: Pyrrhocoridae), Lygaeid bugs (family: Lygaeidae)

a. Southern green stink bugs (family: *Nezara viridula*): the stink bugs, which seemed to belong to this species, were detected with Myanmar sesame. They give sucking damages to the various agricultural products including sesame. Basically, they are green-colored but the type with white and yellow belts are observed. It looks like a green *Nezara antennata*.

b. Pyrrhocorid bugs (family: *Dysdercus* spp.): detected very often with sesame in Myanmar. They seem to be the pests to okra or cotton but the possibility for sesame to be attacked is high.

c. Sesamum seed bugs, a kind of Lygaeid bugs (family: *Aphamus sordidus*): Lygaeid bugs, which seemed to belong to this species, were detected with Myanmar sesame. This species give sucking damage to the sesame in the drying period of harvest latter period or post-harvest.

(iv) Scarabs (family: Scarababidae)

Sesamum black beetle, a kind of Scarabs (family: *Anomala antiqua*): outbreaks of the larvas, which seemed to be of this species, were observed. The imagos give feeding damage to the leaves and the larvas give feeding damage to the roots. The damages by the larvas are significant. It is told that Japanese beetles (family: *Popillia japonica*) also give damages. The imago lays eggs preferring the soil with rich organic substances.

(v) Pyralid moths (family: Pyralidae)

Sesamum leaf roller, a kind of Pyralid moths (family: *Antigastra catalaunalis*): most common pest in Myanmar, and also detected in this investigation. This gives the damage by bind the young sesame leaves together.

(vi) Sphinx moths (family: Sphingidae)

Death's head (family: *Acherontia styx*): it was told that this species attack sesame in Myanmar, but we could not detect with sesame. We picked the larvas of Sphinx moths with weeds but could not clarify the species name. The larvas of Death's head give feeding damage not only to sesame but also to eggplants potatoes or peppers. The aged larva of this species is extremely large (body length: about 100mm) and has various body colors; green, yellow or brown. And, it has slick skin. The imago has a human-face-looking pattern on its back. The imago does not attack. The larva of Sphinx moths has a spiniform organ called "cercus". There are various opinions on its function. It looks scary if you are not familiar with an insect. And, *Psilogramma incretum* also attacks sesame.

(vii) Tiger moths (family: Arcitiidae)

Common hairy caterpillar, a kind of Lemyra imparilis (family: *Spilosoma obliqua*): they were detected with sesame in cultivation latter period or during drying. It consumes an extreme amount of leaves. It belongs to the same family with *Hyphantria cunea* which attacks the street trees in Japan.

(viii) Owlet moths (Cutworms) (family: Noctuidae)

Tobacco budworm (family: Helicoverpa armigera), *Spodoptera litura (family: Noctuidae): it seems that sesame in Myanmar are attacked by various Owlet moths.* We detected Owlet moths, e.g. Tobacco budworm, in this investigation.

(xi) Others

Nematodes (family: Pratylenchidae) and others: we did not investigate targeting Nematode this time, but Nematode is being generated according to the farmers and they control it with carbofuran (carbamate insecticide). As for other diseases than virus disease and phytoplasma disease, the occurrence of Rhizoctonia disease was high (pathopoiesis stump rate at outbreak farms were 9%).

5) Natural enemies of sesame pest occurrence status

The sesame insect pests also have a wide variety of natural enemies. According to the

information collected in Japan, Parasitic wasps, Ladybird beetles, Green lacewings, Predaceous bugs (Leaf bugs or Assassin bugs), Hoverflies, Gall midges, Phytoseiid mites or Spiders are known as natural enemies (Japan Plant Protection Association, 2006; Rural Culture Association Japan, 2016) It is considered that these natural enemies can be the great selection pressure to prevent proliferation of the pests at farms as the native natural enemies. In the sesame production area of Kikai-ga-jima of Kagoshima prefecture, Nesisiocoris tenuis is being observed (based on the information from Oshima Branch, Kagoshima Prefectural Institute for Agricultural Development). However, Nesisiocoris tenuis sometimes attacks sesame, and it has also the functionalities as a pest.

We conducted our investigation at the sesame farms and peripheral land with weeds to clarify the natural enemies to sesame pest occurrence status in Myanmar. As the results of that, we confirmed the natural enemy occurrence status as follows.

(1) Natural enemies to sesame pest investigation result

Investigation result of natural enemies to sesame pests are as indicated in Table 3-9 and Table 3-10. We confirmed the occurrence of Green lacewings, Ladybird beetles, Parasitic wasps, Predaceous bugs, and Spiders with sesame during cultivation. In addition, many Dragonflies are flying and coming for preying activity during sesame husking. However, the natural enemy complex is not generally rich enough.

Table 3-9. Natural enemies on sesame in Myanmar (Sweeping method and direct counting method, June, 2017)

Abbr.	Chrysopidae	Coccinellidae	Parasitic wasps Eulophidae Braconidae etc.	Predatory bugs Miridae Geocoridae Reduvidae	Araneae	Other	Remarks
#1	0	0	0	0	0	Earwig 1	Direct
#2	0	0	0	2	1	0	Sweeping
#3	1	0	0	3	1	0	Direct
#4	0	0	0	5	0	0	Swepping
#5	0	0	0	1	0	0	Direct
#6	0	0	0	0	0	0	Sweeping
#7	0	0	0	2	0	0	Sweeping
#8	0	0	0	0	0	0	Sweeping
#9	0	0	0	0	0	0	Sweeping
#10	0	0	0	0	0	0	Swepping
#11	0	0	0	0	0	0	Sweeping
#12	0	0	0	0	0	0	Sweeping
#13	0	0	2	0	0	0	Swepping
#14	0	0	0	3	0	0	Sweeping
#15	0	0	0	0	0	0	Direct
#16	0	0	2	0	2	0	Sweeping
#17	0	0	3	0	0	0	Sweeping
#18	0	0	0	0	0	0	Sweeping
#19	0	0	1	3	0	0	Sweeping
#20	0	0	2	0	1	0	Sweeping
#4 Y trap	0	0	0	2			
#4 Y trap	0	0	0	1			
#5 Y trap	0	0	0	1			
#5 Y trap	0	0	0	3			

Table 3-10. Natural enemies on sesame in Myanmar (Sweeping method and direct counting method, July, 2017)

Abbr.	Chrysopidae	Coccinellidae	Parasitic wasps Eulophidae Braconidae etc.	Predatory bugs Miridae Geocoridae Reduvidae	Araneae Thomisidae etc.	Remarks
#1	0	0	1	0	0	
#2	0	0	0	1	0	
#3	0	0	0	0	0	
#4	0	0	0	1	0	
#5	0	0	0	0	2	
#6	0	0	0	0	0	
#7	0	0	0	0	2	
#8	0	0	0	0	0	
#9	0	0	0	2	0	
#10	1	1	0	0	0	
#11	0	0	0	0	0	
#12	2	2	1	0	0	
#13	0	0	0	0	0	
#14	0	0	0	0	0	
#15	0	0	0	1	0	
#16	0	0	0	0	0	
#17	0	0	0	0	0	
#18	0	0	0	0	0	
#19	3	3	0	0	3	
#20	0	0	0	1	2	
#10 Y trap	0	0	0	0		
#12 Y trap	0	0	1	0		
#16 Y trap	0	0	2	0		
#17 Y trap	0	0	1	0		

(2) Investigation result on the natural enemies with weeds

Investigation result of the peripheral weeds around sesame farms are as indicated in Table 3-11 and Table 3-12. We detected Parasitic wasps, Predaceous bugs and Spiders as the natural enemies. The varieties of natural enemies with peripheral weeds are small and the density was also low.

Table 3-11. Natural enemies on weeds in Myanmar (Sweeping method, June 2017)

Abbr.	Chrysopidae	Coccinellidae	Parasitic wasps Eulophidae Braconidae etc.	Predatory bugs Miridae Geocoridae Reduvidae	Thomisidae etc.	Other	Remarks
#1	Non-investigation						
#2	0	0	0	0	1	0	
#3	0	0	0	0	0	0	
#4	0	0	0	5	2	0	
#5	Non-investigation						
#6	0	0	1	0	0	0	
#7	0	0	0	0	0	0	
#8	Non-investigation		0				
#9	Non-investigation						
#10	0	0	0	0	0	0	
#11	0	0	0	0	0	0	
#12	Non-investigation						
#13	Non-investigation						
#14	Non-investigation						
#15	Non-investigation						
#16	Non-investigation						
#17	0	0	0	0	0	0	
#18	Non-investigation						
#19	Non-investigation						
#20	0	0	3	0	0	0	

Table 3-12. Natural enemies on weeds in Myanmar (Sweeping method, July, 2017)

Abbr.	Chrysopidae	Coccinellidae	Parasitic wasps Eulophidae Braconidae etc.	Predatory bugs Miridae Geocoridae Reduvidae	Araneae Thomisidae etc.	Remarks
#1	0	0	0	0	0	
#2	0	0	0	0	0	
#3	Non-investigation					
#4	0	0	0	0	0	
#5	0	0	0	0	0	
#6	Non-investigation					
#7	Non-investigation					
#8	0	0	0	0	0	
#9	Non-investigation					
#10	Non-investigation					
#11	0	0	0	0	0	
#12	Non-investigation					
#13	Non-investigation					
#14	Non-investigation					
#15	Non-investigation					
#16	Non-investigation					
#17	Non-investigation					
#18	Non-investigation					
#19	Non-investigation					
#20	0	0	0	0	0	

(3) Outline of Myanmar's natural enemies to sesame pests

The biology of the main natural enemies to sesame pests confirmed by the investigation on sesame and peripheral weeds are as follows (Rural Culture Association Japan, 2016).

(i) Green lacewings (family: Chrysopidae)

The larvas prey Aphids, Red spider mites or Thrips. *Chrysoperla carnera formulation (product name: Kagetaro) targeting Aphids is sold in Japan.*

(ii) Ladybird beetles (family: Coccinellidae)

Both imagos and larvas prey Aphids or Scale insects. *Harmonia axyridis formulation (product name: Ten-Top) and for Propylea japonica (product name: Kamenoko S) targeting Aphids are sold in Japan.*

(iii) Parasitic wasps (family: Braconida or Eulophidae)

The Parasitic wasps as the native natural enemy like Parasitoid wasps mainly attack Lepidoptera pests (Owlet moths, Sphinx moths or Tiger moths). And, Aphids are also attacked by Parasitic

wasps. Many parasitic wasp *formulations are sold in Japan such as Aphidius colemani formulation (product name: Aphipar or Cole-Top) targeting Aphids.*

(iv) Predaceous bugs (family: Miridae, Geocoridae and Reduvidae)

a. Leaf bugs: powerful natural enemies to Thrips or Whiteflies who are the natural enemies to vegetables or flowering plants. *Nesisiocoris tenuis is a well-known one.* They sometimes give sucking damage to the agricultural products but the damage is small.

b. Big-eyed bugs: both imagos and larvas prey the young larvas of Thrips, Red spider mites, Aphids, Whiteflies and Lepidoptera. *Geocoris varius* formulation (product name: Oome-Top) is planned to be sold targeting Thrips.

c. Assassin bugs: prey various varieties of insects. Attention must be paid to them, as some of these varieties bite human varieties to transmit the infection (Chagas' disease).

6) Control method of sesame pests

There are various control methods to exterminate pests. They can be classified, for descriptive purposes, into "chemical control method, physical control method, ecological (cultural) control method, biological control method". Various control measures are also taken in Myanmar (Crop protection branch, 1999). We would like to introduce the actual status of sesame cultivation in Myanmar to consider the desirable control methods.

MAFF formulated the IPM Practice Guidelines (MAFF, 2005) which introduced the basic line of thinking on IPM (Integrated Pest Management) to recommend its practice in agricultural products cultivation. IPM theory was recognized all over the world, and it is considered that Myanmar should introduce it in its sesame cultivation. In order to do so, it is required to conduct various investigations and researches (biology clarification of the pests and natural enemies, establishment of the occurrence forecasting technology, damage analysis, development of the various control methods, and preparation of the IPM manual). First of all, it is needed to analyze the biology of the insect pests and natural enemies to develop the various control methods of them. These procedures agree with GAP (Good Agricultural Practice) spirit Myanmar is promoting.

(1) Chemical control method

In Myanmar, various restrictions have been enforced on chemical pesticides. Also, the risk of pesticides is assessed (Peeters et al., 2015). The following eight pesticides including deltamethrin and phenthoate are recommended in Myanmar as pesticides to be used for sesame (Table 3-13).

Table 3-13. Main insecticides recommended for sesame insect pests in Myanmar

Component name	Main trade name	Characteristic
deltamethrin 2.5% EC	Decis	> synthetic pyrethroid insecticide > cotton bollworm
diazinon 40.0% EC	Diazinon	> organophosphorus insecticide > sesamum leaf roller > death's head moth > common hairy caterpillar > sesamum blask beetle
dimathoate 40.0% EC	Dimathoate	> organophosphorus insecticide > esamum jassid > sesamum leaf roller
fenitrothion 50.0% EC	Sumithion	> organophosphorus insecticide > death's head moth > sesamum blask beetle
fenpropathrin 10.0% EC	Danitol	> synthetic pyrethroid compound insecticide > sesamum jassid
imidacloprid 70.0% D and 20.0% WP	Gaucho and DOZER	> neonicotinoid insecticide > sesamum jassid
malathion 50.0% EC	unknown	> organophosphorus insecticide > death's head moth
phenthoate 50.0% EC	unknown	> organophosphorus insecticide > cotton bollworm > common hairy caterpillar

Source: Main insecticides were quoted from the technical booklet of Crop protection branch, Myanmar in 1999.

These chemical pesticides are described in “Pests affecting sesamum plants in Myanmar” (original version is written in Burmese) issued by Plant protection division (1999) with their usage instructions. This technical data (Initial edition was issued in 1999, number of revised version is unclear) is still widely used by the DOA and DAR as a guidance for diseases and pests of sesame. Seven pesticides excluding deltamethrin of the eight pesticides shown in the data are used in Japan as of 2017.

The DOA and DAR impose tough guidance on farmers about usage of chemical pesticides keeping issues of pesticide residue in mind. Farmers answered they follow the guidance in interviews. However, some farmers did not necessarily understand proper use of proper pesticides and others did not grasp the details as they were as they outsourced pesticide inputs.

(i) Deltamethrin 2.5% emulsion (Representative product name: Decis)

Synthetic pyrethroid pesticide. Effective for worms of lepidopterous pests and stink bugs. It is used for Helicoverpa armigera on sesame. It seems to be used for hygiene pests (mosquitoes and flies). It is not sold in Japan.

(ii) Diazinon 40.0% emulsion (Representative product name: Diazinon)

A highly pervious organophosphorous pesticide. Effective for ant cows, dodgers, worms of

lepidopterous pests and chafers. It is used for a form of pyralids, Eastern Death's Head hawkmoths, a form of tiger moths and a form of chafers on sesame. In Japan, diazinon 40.0% (Product name: Diazinon Emulsion etc.), 5.0%% (Product name: Diazinon Granule etc.) and 25.0% (Product name: Diazinon Cupsule etc.) are sold. Diazinon 5.0% is available for chafers on sesame.

(iii) Dimethoate 40.0% emulsion (Representative product name: Dimethoate)
A highly pervious organophosphorous pesticide. Effective for ant cows and dodgers. It is used for a form of dodgers and a form of pyralids. In Japan, dimethoate 43.0% (Product name: Dimethoate Emulsion etc.) and 5.0%% (Product name: Dimethoate Granule etc.) are sold.

(iv) Fenitrothion 50.0% emulsion (Product name: Sumithion)
Organophosphorous pesticide with a lower zoonotic toxicity developed by Sumitomo Chemical Co. Effective for ant cows, worms of lepidopterous pests, stink bugs and chafers. It is used for Eastern Death's Head hawkmoths and a form of chafers on sesame. In Japan, fenitrothion 50% (Product name: Sumithion Emulsion etc.) is sold. It has been widely used for a long time in Japan (registered in 1961).

(v) Fenpropathrin 10.0% (Product name: Danitol)
Synthetic pyrethroid pesticide with lower zoonotic toxicity developed by Sumitomo Chemical Co. Effective for ant cows, worms of lepidopterous pests and red spiders. It is used for a form of dodger. In Japan, fenpropathrin 70.0% (Product name: Rody Emulsion etc.) is sold.

(vi) Imidacloprid 70.0% powder, 20.0% wettable powder (Representative product name: Gaucho, DOZER)
Neonicotinoid pesticide with a penetration transfer activity and a higher residual efficacy. Effective for ant cows, dodgers and beetles. It is used for seed treatment intended for dodgers on sesame. In Japan, imidacloprid 70.0% (Product name: Gaucho Powder etc.) and 20.0% (Product name: ADMIRE Flowable Wettable Powder etc.) are sold.

(vii) Malathion 50.0% emulsion (Representative product name: Unknown)
Organophosphorous pesticide. Effective for sucking pests (ant cows and dodgers etc.) and chewing pests (worms of lepidopterous pests etc.) It is used for Eastern Death's Head hawkmoths on sesame. In Japan, malathion 50% (Product name: Malathion Emulsion etc.) is sold.

(viii) Phenthoate 50.0% emulsion (Representative product name: Unknown)
Organophosphorous pesticide. Effective for ant cows, worms of lepidopterous pests and stink

bugs. It is used for Helicoverpa armigera anda form of tiger moths on sesame. In Japan, phenthoate 20.0% (Product name: Elsan Emulsion etc.) is sold.

As a result of interviews with farmers and pesticide shops, it was found that pesticide shops sold the following pesticides. In addition to the eight pesticides described above, the following pesticides are widely used. Though they seem to be effective for various sesame pests, availability on sesame, utilization and problems are unclear.

(i) Acephate, Representative product name: AZPHATE
A highly pervious organophosphorous pesticide. Effective for ant cows and worms of lepidopterous pests. In Japan, acephate 15.0% (Product name: Acephate etc.) and 50.0%% (Product name: Acephate Wettable Powder etc.) are sold.

(ii) Acetamiprido and lambda-cyhalothrin admixture (Representative product name: Better)
This is an admixture. Acetamiprid is a neonicotinoid pesticide like imidacloprid with a penetration transfer activity. Effective for worms of lepidopterous pests etc. Cyhalothrin is a synthetic pyrethroid pesticide. Beneficially effective for worms of lepidopterous pests etc. In Japan, acetamiprid 15.0% (Product name: Mospilan Liquid etc.) and cyhalothrin 5.0%% (Product name: Cyhalothrin Wettable Powder etc.) are sold.

(iii) Aluminum phosphide, Representative product name: Unknown
Aluminum phosphide fumigant effective for grain-storage insects. It is used for fumigation of sesame. In Japan, aluminum phosphide (Peoduct name: Epifume, Hostxin Fumigation etc.) and used for grain-storage insects on sesame.

(iv) Carbofuran, Representative product name: Fradan
Carbamat pesticide effective for various pests in addition to nematodes. However, it has a strong zoonotic toxicity and a heavy environmental load. In Japan, carbofuran derivative carbosulfan 3.0% and 5.0% (Product name: Gazette Granule, Advantage Granule etc.) is sold.

(v) Chlorpyrifos, Representative product name: Phosdrin
Organophosphorous pesticide. Effective for worms of lepidopterous pests etc. In Japan, chlorpyrifos 40.0% (Product name: Dursban Emulsion etc.) is sold.

(vi) Admixture of emamectin benzoate and lambda-cyhalothrin1, Representative product name: TALAM

Emamectin benzoate is a macrolide pesticide. Effective for various pests such as worms of lepidopterous pests etc. In Japan, emamectin benzoate 1.0% (Product name: Affirm Emulsion etc.) is sold.

(vii) Permethrin, Representative product name: Unknown
Pyrethroid pesticide. Effective for ant cows, dodgers, worms of lepidopterous pests and stink bugs. In Japan, permethrin 20.0% (Product name: Adion Emulsion etc.) is sold.

Meanwhile, a limited number of pesticides are available in Japan. Though 4,000 types of pesticides, only five are available for sesame (Japan Plant Protection Association, 2015, 2017). As pesticides, permethrin 20.0%, saccharified reduced starch 60.0%, chlorantraniliprole 5.0% and diazinon 5.0% are available in japan (Table 3-14). As a disinfectant for a bacterial blight disease and copper hydroxide 61.4% (40.0% as copper) (Product name: Kocide DF) are available.

Table 3-14. Permitted insecticides to sesame insect pests in Japan

Component name	Main trade name	Characteristic
chlorantraniliprore 5.0% WP	Prevathon	> diamide insecticide > cotton bollworm
diazinon 40.0% GR	Diazinon	> organophosphorus insecticide > cutworms
permethrin 20.0% EC	Adion	> synsetic pyrethroid insecticide > aphids
saccharified reduced starch 60.0% SL	Ecopita	> polysaccharides insecticide > aphids

(i) Chlorantraniliprore 5.0% (Representative product name: Prebason Flowable)
Diamide pesticide. It is available for sesame under the following conditions: Target: Helicoverpa armigera, Dilution ratio: 2,000 times, Dispersal period: By 14 days before harvesting, Number of times of dispersal: Twice, Amount of dispersal: 100-300L/10a Granule is also available in addition to wettable powder. As to crops other than sesame, it is used for worms of lepidopterous pests (including cutworms) and leafminers.

(ii) Diazinon 5.0% (Representative product name: Diazinon Granule 5)
Organophosphorous pesticide. It is available for sesame under the following conditions: Target: Cutworm, Dispersal period and Number of times of dispersal: Once before sowing, Amount of dispersal: 6kg/10a Emulsion, water poweder and microcapsule are available in addition to granule. As to crops other than sesame, it is used for ant cows, worms of lepidopterous pests (including

cutworms), worms of chafers, mole crickets and seed-corn flies.

(iii) Permethrin 20.0%, Representative product name: Adion Emulsion)
Synthetic pyrethroid pesticide. It is available for sesame under the following conditions: Target: Ant cows, Dilution ratio: 2,000 times, Dispersal period: By three days before harvesting, Number of times of dispersal: Three times or fewer, Amount of dispersal: 100-300L/10a Liquid, water powder and granule are available in addition to emulsion. As to crops other than sesame, it is used for worms of lepidopterous pests and stink bugs.

(iv) Saccharified reduced starch 60.0% (Representative product name: Ecopita Liquid)
It is an oligosaccharide-derived saccharified reduced starch (even used in food), producing an insecticidal effect by blocking spiracles of pests. It is available for sesame under the following conditions: Target: Ant cows, Dilution ratio: 100 times, Dispersal period: By the day before harvesting, Number of times of dispersal: No limit, Amount of dispersal: 100-300L/10a As to crops other than sesame, it is used for red spiders, whiteflies and powdery mildew.

(2) Physical control method

Physical control methods such as capture and killing, blocking, measures using light, color and heat are safe control methods. Especially, capture and killing is the most basic control method requiring no special materials. Other than capture and killing, insect screening, reflective multi-sheets and yellow and blue sticky boards are effective. Physical control methods have gained an important position in IPM (Integrated Pest Management), which should be introduced as they are safe.

Capture and killing of worms of hawk moths and noctuids is effective for cultivation of sesame in Myanmar. Insect screening (net spreading) can be easily introduced at an agricultural field in the drying period.

(3) Ecological and cultural control method

Ecological and cultural control methods by rotational cropping, companion cropping, intercropping, transplanting, cleaning, barrier crops, antagonistic plants, maturing management and resistant varieties prevent pests from propagating themselves. Many farmers have introduced the methods on an empirical basis.

Growing gramineous crops (corns and sorgos etc.) around sesame as barrier crops can reduce parasitism of ant cows on sesame. They also have a windbreak effect. Sesame is a crop unsuitable for continuous cropping. Avoiding continuous cropping can reduce diseases and nematodes. Improving drainage performance of an agricultural field has a positive impact on cultivation of

sesame. Introducing these methods in Myanmar can create an agricultural environment suitable for cultivation of sesame.

(4) Biological control method

Biological control methods are ones using natural enemy pesticides and indigenous natural enemies. Natural enemy pesticides are also called biopesticides and used as pesticides. A variety of biopesticides are sold now (Japan Plant Protection Association, 2006, 2015; Rural Culture Association Japan, 2016). In the global trends for safety of agricultural products, cultivation crops with as little chemical pesticide use as possible has been promoted. Biopesticides are actively used for minute pests difficult to be controlled only by chemical pesticides (whiteflies, thrips, ant cows and red spiders).

Indigenous natural enemies are used to an anti-pest agricultural field. There is a move to promote use of indigenous natural enemies in IPS, which is called Biointensive IPM. Plants preserving natural enemies (sesame, gombo, sorgo and flowers etc.) are planted around crops to propagate and preserve indigenous natural enemies. Sesame, well known as a plant preserving natural enemies, is used to propagate and preserve mirid stink bugs. Control by propagating natural enemies and placing banker plants is practiced in greenhouses and PVC greenhouses. It is called the banker method as natural enemies are deposited to these plants and withdrawn when pests break out. In cultivation for preserving natural enemies, selective pesticides (insect growth inhibitors and biopesticides etc.) least disruptive to natural enemies are used in a least disruptive manner.

Pheromone, categorized into one of biopesticides, is available for sesame pests. A mating disruptor (Product name: Konagakon) for Helicoverpa armigera has been developed. Though this method is extremely effective to disrupt mating of adults and reduce the next-occurrence density, it requires money and time. It must be worked on by the village level, not by individual level. It is worthwhile to introduce in areas damaged the most by Helicoverpa armigera.

According to Myint (2005), control of goldeneyes (Target: Ant cows and mealy bugs), Andrallus spinidens, *Eocanthecona furcellata* (Target: Helicoverpa armigera), entomopathogenic fungi *Metharizium anisopliae* (Target: Worms of lepidopterous pests) is attempted in Myanmar. Furthermore, neem flowable and Bacillus thuringiensis (BT) water powder are also used.

Though various indigenous natural enemies live in weeds in and around sesame farms, the overall natural enemy fauna is not so rich. It is necessary to promote investigations of propagation of indigenous natural enemies and take measures to propagate them. Furthermore, it is desirable to share recognition on natural enemies with persons concerned in plant protection (farms, pesticide dealers, extension officers, research workers and administrative workers etc.). This develops an atmosphere conducive to protection of indigenous natural enemies.

7) Technology transfer and sharing of information

In the second dispatch, a workshop (WS) for sesame was held in study regions, Magway T/S and Nay Pyi Taw for technology transfer and sharing of information. The DOA provided topics related to soil and fertilizers, and diseases and pests. The DAR provided topics related to variety. The Japanese side provided topics related to soil and fertilizers, and diseases and pests. A practical debate was sparked up among farmers and the DOA, DAR, persons concerned in various projects and information was shared among those involved.

In the WS, the following topics related to diseases and pests were debated.

(1) Solution for the problem of pesticide residue
(2) Period of using pesticides
(3) Problematic diseases and pests
(4) Recognition of the problems of pesticide residue and diseases and pests
(5) Method and period of drying after harvesting

4. Important point on technologies

It seems that it has been generally recognized that there remain problems on “pesticide residue” , not on “diseases and pests” about sesame in Myanmar. However, it is a factual error. There are problems of diseases and pests in Myanmar, which farmers are very concerned about. Those involved must recognize the problems of diseases and pests underlie those of pesticide residue. Therefore, points relating to technology are listed below.

1) Ecological knowledge

It is necessary to accumulate ecological knowledge on major diseases and insect pests of sesame to solve the problems. For example, damage caused by phytoplasma transmitted by a form of dodgers was thought to be the most serious in this survey. Information on annual propagation and survival of phytoplasma transmitting pests (density and period of propagation) is important to effectively control them. Public research institutions and extension institutions must survey temporal propagation and survival of major pests including transmitting ones by cropping type annually. As propagation and survival vary depending on the year, they must be surveyed annually. Accumulated data is indispensable for control of diseases and pests.

2) Various control methods

Various control methods (chemical, physical, ecological and cultural and biological methods) must be applied based on ecological information. Therefore, public institutions must develop various technologies concerning the control methods. Furthermore, seeing protection from

diseases and pests from a viewpoint of IPM (Integrated Pest Management), we would like to build an anti-pest environment, predict propagation of diseases and pests, analyze damage and build IMP for sesame original to Myanmar based on these technologies.

3) Conveyance of information

We will try to convey ecological information of major diseases and pests and information on control methods to farmers through seminars and delivery of technical data. Extension officers and research workers of public institutions can keep communication with farmers by visiting them frequently for surveys. In Myanmar, farmers seem to obtain information on diseases and pests and protection from pesticide dealers etc. In cooperation with pesticide dealers etc., public institutions must be careful to prevent protection heavily depending on chemical pesticides.

4) Proper use of proper pesticides

Chemical pesticides (pesticides and germicides etc.) are not always used properly. For example, some chemical pesticides available for agricultural products are widely used even if they don't target sesame. Pesticides must be selected from various viewpoints such as an effect of protecting from diseases and pests, zoonotic toxicity, influence on environment and pesticide residue. Furthermore, the effect of protecting from diseases and pests, dispersion period and dilute concentration etc. under the sesame cultivation in Myanmar must be clarified and labeled on pesticide containers. Farmers must understand the labels and observe the target crops, target diseases and pests, dispersal periods and dilute concentrations etc. Methods of dispersing pesticides are also important. Though chemical pesticides are dispersed with toting-type dispersers (manual and automatic), this method is unavailable in a large agricultural field.

5) Problems of pesticide residue and diseases and pests

Problems of diseases and pests underlie those of pesticide residue must be recognized. Those involved seem to attend to analysis of dispersal periods when no problems of pesticide residue occur and pesticide residue etc. In order to solve fundamental problems, it is required to clarify the number of days of usage before investing and the remaining amount of pesticides and determine proper dispersal periods by type of chemical pesticides used for sesame. Analysis of pesticide residue is important, though, proper use of proper pesticides must be practiced first based on ecological knowledge on major diseases and pests.

5. Technical proposal

Keeping important point on technologies in mind, we will make technological proposals about problems of diseases and pests and pesticide residue on sesame. The DOA and DAR must provide farmers with information on diseases and pests and proper control methods annually. For this purpose, ecological investigation and research of major diseases and pests on sesame and development of various control methods are imperative. When chemical pesticides are used, proper use (dispersal periods and dispersal densities etc.) of proper pesticides (ones approved for sesame) must be familiarized.

Farmers are afraid and concerned about diseases and pests, which are unknown. It is fear and concern about diseases and pests that causes the problems of diseases and pests. If appropriate solutions are provided for the problems of diseases and insect pests sesame farmers can accept, the problems will be automatically solved.

1) Before sowing

(1) It is recommended to treat sesame seeds with imidacloprid (Crop protection branch, 1999). Though we were not able to see the treatment, we obtained information “There is fear that containers etc. to be used for treatment of sesame seeds with pesticides are also used for product sesame”.

(2) Seed sesame and product sesame must be clearly separated. When seed sesame treated with pesticides is excessive, it must not be sold as product one.

2) Preceding period of cultivation (Sowing period - flower initiation period: Vegetative growth period)

(1) Viruses and phytoplasmas are transmitted by ant cows and dodgers in this period, with damage appearing in the latter period of cultivation. To prevent diseases, transmission must be prevented.

(2) Though it is difficult to find transmitting pests as they are minute, their propagation must be confirmed in this period. Protection measures must be taken before propagation increases.

(3) Permeable organophosphorous pesticides are effective. Follow the instructions of the DOA and DAR when selecting chemical pesticides.

(4) As an ecological and cultural control method, use of gramineous crops (corns and sorgos etc.) seems to be effective to prevent small pests from entering agricultural fields.

3) Latter period of cultivation (Flowerage period - Harvesting period: Generative growth)

(1) Disease symptoms caused by viruses and phytoplasmas become remarkable in this period. As a physical control method, pathopoiesis stumps are removed and brought out of agricultural fields

as soon as they are found

(2) Worms of lepidopterous pests with mouthparts propagate and sometimes cause a heavy damage. Attention must be paid to worms of chafers as they east too many roots of sesame in the soil. As a chemical control protection, synthetic pyrethroid and organophosphorous pesticides are effective for worms of lepidopterous pests. For worms of chafers, dispersal of an organophosphorous pesticide (granule) is effective.

(3) However, the Myanmar government instructs farmers to refrain from disperse pesticides in the latter period of cultivation, It is inevitable as an emergency measure. However, as periods of residue depend on pesticides, the number of days when pesticides are used before harvesting sesame under the cultivation environment in Myanmar must be clarified. Anyway, more detailed instructions are required about the types and dispersal periods of pesticides.

(4) As a physical control method, capture and killing is effective. Though various biopesticides are available, use of indigenous natural enemies is desirable in future years. Pay attention to organic-rich soil as it induces egg laying of adult chafers.

4) Drying period after harvesting

(1) Though pests such as stink bugs harm agricultural fields in the drying period after cultivation, no chemical pesticides are not dispersed to prevent residual pesticides in this period.

(2) Farmers recognize drying is required in agricultural fields, it is no desirable in terms of pest problems. As quality deterioration of sesame has been indicated, it is desirable to review the drying periods and methods themselves.

(3) Agricultural work done by farmers for a long time frequently is rational to a certain degree in their agricultural environments. Sun drying is widely used for various agricultural products. As to reviewing the drying method for sesame, it is required to organize advantages and disadvantages of drying in agricultural fields, clarify the reasons for proposing a new drying method.

6. Major reference

(1) Crop protection branch (1999) Pests affecting sesamum plants in Myanmar. Crop protection branch, Myanmar agriculture enterprise, Myanmar, p. 23 (In Burmese).

(2) Ministry of Foreign Affairs of Japan HP (http://www.mofa.go.jp/) (Browsed in June, 2017)

(3) Japan Meteorological Agency HP (http://www.jma.go.jp/) (Browsed in June, 2017)

(4) Yu Kikuchi, Cho Lin, Naing Aung, Myo Taewoong (2016) Wather conditions of target areas The project for development of water saving agriculture technology in the central dry zone, Mandalay. 13 PP.

(5) JICA and Sanyo Consulting Inc (2013) Data collection survey on agriculture sector in the republic of the union of Myanmar Final report. Japan international cooperation agency and Sanyo consulting inc, Tokyo. 157 PP.

(6) Eiichi Kusano (2013) Agricultural situation in Myanmar Agriculture November issue (No. 1578) 62-66.

(7) Myint, U. M. (2005) Myanmar. In the proceedings Asia regional workshop: Implementation, monitoring and observance: International code of conduct on the distribution and use of pesticides published by FAO. http://www.fao.org/docrep/008/af340e/af340e0e.htm#bm14 (Browsed in July, 2017).

(8) Major insect and other pests of economic plants in Japan (Revised and enlarged) (2006) Japanese Journal of Applied Entomology and Zoology, Tokyo 387 PP.

(9) Biopesticides + pheromone Guide Book 2006 (2006) Japan Institute of Plant Protection Association of Japan, Tokyo 1,089 PP.

(10) Pesticide Handbook 2016 (Revised Edition) (2015) Japan Institute of Plant Protection Association of Japan, Tokyo 1,089 PP.

(11) Plant protection 2017 (2017) Japan Institute of Plant Protection Association of Japan, Tokyo 210 PP.

(12) NAROPEDIA (2006) (National Agriculture and Food Research Organization) Rural Culture Association Japan, Tokyo 2,003 PP.

(13) Ministry of Agriculture, Forestry and Fisheries HP (http://www.mofa.go.jp/) (Browsed in June, 2017)

(14) Ministry of Agriculture, Forestry and Fisheries (2005) Integrated Pest Management (IPM) Practical Guideline http://www.maff.go.jp/j/syouan/syokubo/gaicyu/g_ipm/ (Browsed in June,

2017)

(15) Encyclopedia of natural enemies and their use for biological control in IPM (2016) Rural Culture Association Japan, Tokyo 776 PP.

(16) Peeters, F., J. van Meggelen and H. Schepers (2015) Crop protection and pesticide risk assessment Myanmar -Towards sustainable agricultural production and export of high value crops-. Alterra report 2621, p. 82.

(17) Kimihiko Sato, Shuichi Yamashita, Yasuo Honma, Handbook of diseases and insect pests in plant (2001) Asakura Publishing Co., Ltd., Tokyo 494 PP.

(18) Tomoko Yasumoto (2008) Factors affecting variation in the sesamin and sesamolin contents of sesame (Sesamum indicum L.) seeds, varietying of a new lignan-rich sesame cultivar and evaluation of the functionality of the seeds in fatty acid metabolism Bulletin of the National Institute of Crop Science　9:27-61.

III Pesticide

Dr. Masahiko Kuwahara

1. Visited DOA Magway Office

(June 23)

Director Mr. Khin Maung Win explained that they instructed farmers to improve methods of using pesticides and reduce the amount of usage according to the guideline of the GAP, focused on postharvest usage of pesticides and recommended the use of less-toxic neem oil. They instruct farmers to use imidacloprid twice or fewer and avoid dispersing pesticides after flowering. He also explained they asked Yangon for measurement of residual pesticides in agricultural products and received a result that no pesticides remained in all samples last year. They answered our question about which disturbed production of sesame in the area, pests or diseases, saying smooth rainfall after sowing is the most important and diseases and pests were not decisive factors.

2. Interviews with Pesticide Dealers

(June 23)

Though we had interviews with three dealers, all pesticides they sold were registered pesticides and no unregistered pesticides were confirmed. However, some of these pesticides contain carbofuran, which cannot be ude in Japan due to its high zoonotic toxicity and penetrating migration characteristics and adverse effect on water creatures. It is necessary to clarify whet administrative guidance has been rendered about the use of the pesticide.

It was revealed that a dealer recommended sesame farmers that visited the dealer to use carbofuran in seed dressing at the time of sowing, admixture of acetamiprid or imidacloprid and a germicide in 30-45 days after sowing and admixture with synthetic pyrethroid such as emamectin and cypermethrin in 60 days or later of the flower initiation period. Therefore, the dealer recommended pesticides that corresponded to purposes of controlling sucking pests with pesticides with penetrating migration characteristics and chewing pests with contact pesticides in the sesame growth period. The dealer also recommended to disperse imidacloprid or acetamiprid for stink bugs that damage shells stored outside on fields after sesame leaves and stems were harvested.

3. Field survey (June 24-27)

(June 24)

We conducted a survey on propagation of diseases and pests in Kyaung Su village and San Pya village located in plains at low altitudes in Magway Region and had interviews with farmers about propagation of diseases and pests and usage of pesticides. Both the villages irrigation facilities

and fields for producing sesame, rice and beans annually. At the time of the survey, they were in the harvest seasons and some farmers started preparation of the next seed bed.

The former village had ill-drained heavy soil areas where the height of sesame was low, the number of pod settings was small and growth was poor. Broadcast sowing was used and no ridges were made. We found many virus diseases caused by minor sucking pests and phyllodies caused by phytoplasmas. The latter village had well-drained heavy soil areas where cattle feces and plaster were used. Broadcast sowing was used, growth was relatively good and almost no pesticides were dispersed. Like the former village, they suffered from phyllodies. After pilling sesame stems on fields, farmers dispersed imidacloprid or acetamiprid etc. when damage caused by sucking pests (mainly stink bugs) on their top and sides. Dr. Azusa Fujiie, an accompanying specialist, placed an adhesive trap for occurrence prediction.

(June 25)

Agricultural areas spread over relatively higher grounds of Magway Region. In the majority of the areas, sesame and beans are produced annually using rain water. Most areas are covered by sandy soil. In some areas, soil erosion is problematic. We surveyed three agricultural fields.
In the morning, we surveyed the field of 40 hectares managed by a farmer in San Ma Kyi. Sesame grew to 35 cm of intra-row spacing and 15 cm of intra-row spacing in two to three weeks after sowing. Though the farmer told they used no pesticides, we found no remarkable diseases and pests in the middle of the sesame growth period.

We surveyed agricultural fields owned by a company. We found that higher areas of the fields were covered by sandy soil and well drained. Broadcast sowing was used and overall growth was not uniform. Though no soil-borne diseases were found, many virus diseases and phyllodies occurred. Meanwhile, lower pan-like places had a thin surface sandy soil layer. In places where argillaceous soil was distributed just beneath the places, stem rot had broken out. As a reduced crop yield is expected due to vestigial and dead leaves and stems, steady measures for protection must be taken.

In the afternoon, we surveyed agricultural fields managed in accordance with the guideline in Alae Po subject to the GAP's project. Soil management seemed to have a problem as soil was sandy, sowing periods were different and growth of sesame was not uniform. Though almost no soil-borne diseases caused by filamentous bacteria were found, many virus diseases and phyllodies occurred.

(June 26)

Dr. Fujiie recovered the trap placed the day before yesterday in Sann Pya village. In the agricultural field, harvesting of sesame stems and leaves was almost completed and storing of

them was about to end. Then, irrigation was introduced, seedbed was developed and the second rice growing started in the field. We saw patting fully dried sesame shells with a wooden stick and removing seeds in a neighboring field. Leaves and stems from which sesame seeds were removed were dried and used as livestock food and compost feedstock.

(June 27)

In the morning, we surveyed agricultural fields in Can Yway Lay village. Sesame was grown in most agricultural fields, but pigeon pea was grown in some fields. Disease damage was relatively little and fewer virus diseases occurred. However, a quite a lot of phyllodies occurred. In addition to a bioregulator, an admixture of cypermethrin and pesticide and abamectin were dispersed twice with motor sprayers in the vegetative growth period of sesame.

In the afternoon, we visited a crop dealer and its storage house in Pyint Pyu T/S. The quantity of sesame seeds arriving was little. The majority of them were black while the quantity of white sesame seeds was little. In the warehouse, white sesame seeds in black ones were separated by separators. The warehouse was fumigated with alminium phosophide almost every three months. Later, we moved to Nay Pyi Taw.

(June 29)

With Deputy Director Dr. Aye Ko Ko and six persons in the Yezin Headquarters of the DAR in Nay Pyi Taw, we showed our appreciation, announced the results we obtained in this survey and exchanged opinions about cooperation systems including future measures.

The deputy director asked for cooperation among those involved to try to reduce use of pesticides as much as possible without decreasing production and strengthen the functions of local test stations for promotion by introducing GAP. I told it was indispensable to establish a proper usage method of pesticides (proper density, usage period and set test conditions based on my proposals

Later, we visited a facility of proliferate a insect-parasitizing bee, Trichogramma, which was one of the biological control research institutes of Yezin Agricultural University.

4. Summary

Though our trip was only 10 days long, we directly touched various problems in the cultivation environment and production process of sesame seeds which were unfamiliar. In the agricultural fields we surveyed, diseases and pests were observed. Those causing considerable damage were virus diseases and phyllodies caused by phytoplasmas. The disease damage was transmitted by ant cows and dodgers in the initial to middle vegetative growth period of sesame and exhibited symptoms as systemic illness after flower bud differentiation. However, no symptoms appeared

even if the damage was transmitted in the flower initiation period or later with sesame masked as a carrier. Therefore, it is required to exterminate ant cows and dodgers as a vehicle to control the disease damage. It is indispensable to disperse neonicotinoid and carbamat pesticides with penetrating migration characteristics to control these pests. Seed dressing processing for these pesticides and disperse of them in the initial vegetative growth are effective to control disease damage.

Meanwhile, damage is caused by sucking pests, especially, lepidopterous pests he flower initiation period or later. Synthetic pyrethroid pesticides such as cypermethrin, organophosphorous pesticides such as chloropyriphos and antibiotic pesticides such as avermectin are effective to control these pests. Therefore, It must be understood that pests damaging sesame greatly vary depending on the stage of growth of sesame and pesticide to be used also greatly vary.

Chapter 4 Extension of the Technologies

1. Workshop

To share the survey results and instructions widely and spread the outcome, we held half-day workshops in DOA Magway office and DOA Nay Pyi Taw Headquarters (see Annex 2 for workshop agenda). In the workshop in Magway, key farmers, extension officers, government officials, researchers, individuals involved in JICA projects and ITC projects participated. The workshop was held jointly with the DOA and DAR. The DOA provided a comprehensive lecture about overall cultivation of sesame such as production of sesame, problems of diseases and pests, methods of using pesticides, methods of processing after harvesting and characteristics of chemical fertilizers. The DAR introduced characteristics of a new variety of sesame, cultivation method and seed production for delivery etc. Soil specialists dispatched from Japan pointed out problems based on sesame field in Magway and made recommendation about how to improve fertilization methods to increase income. Pest specialists introduced a method of surveying pests and gave a lecture about inhabiting situations of major sesame pests and their natural enemies, pest control methods, proper use of pesticides and IPM method based on the results of the survey in local agricultural fields. Results of deliberation about the contents of the lectures given by Japanese specialists have been reflected on manuals.

In the workshop in Magway, we carried out a questionnaire survey for core farmers and extension officers to confirm the understanding of the lectures and whether knowledge they obtained in their workplaces. As a result, it was revealed that 92% had understood issues in soil and fertilization management, 93% had understood a soil management approach for better sesame production, 97% had understood problematic pests in sesame cultivation and 86% had understood proposed methods of managing pests, which means almost all participants understood the lectures. All participants answered they would like to use obtained knowledge on site and spread it to other farmers and their colleges.

Table 4-1 Questionnaire result (Degree of understanding of the lecture and appetite for spread)

Understood issues in soil and fertilization management	92%
Understood a soil management approach for better sesame production	92%
Would like to use obtained knowledge about soil on site	100%
Would like to spread obtained knowledge about soil to other farmers and colleges	100%
Understood what pests were problematic in sesame cultivation	97%
Understood proposed methods of managing pests	86%
Would like to use obtained knowledge about prevention of diseases and pests on site	100%

Would like to spread obtained knowledge about prevention of diseases and pests to other farmers and colleges	100%
This course was helpful	100%

To share the results of the workshop in Magway we also held a workshop in the headquarters of the DOA in Nay Pyi Taw. DOA staff, DAR staff and those involved in JICA projects participated in the workshop/ We shared recognition with the Ministry of Agriculture, Irrigation and Livestock for solving issues in black sesame cultivation in Magway.

2. Manual

Materials created based on local surveys and technical guidance were revised based on feedback from the workshops and manuals were created from them. The content of the manual and targets are shown below.

Table4-2. Contents of the manuals and their target

Area	Description	Target
Soil fertilization management	Soil management method for sesame in Magway	Farmer and extension officer
Insect Pest management and use of pesticides	Sesame pests, their natural enemies and control methods in Magway	Extension officer and researcher

The soil manual contains a simplified card to be used by an extension officer for guidance and its description (Annex 5 and 6). The disease and pest control and pesticide manual is used for extension officers and researchers as a further investigation must be conducted about pests and control methods (Annex 7).

Chapter 5 General Overview

1. Overview of This Year's Activities

We provided technical guidance to support the improvement of agricultural productivity and quality in black sesame cultivation in the central dry region in Myanmar. We investigated issues concerning the quantity and quality, obtained the current situation and issues from those involved in supply chains doing business with them and in the Ministry of Agriculture, Livestock and. Irrigation (MOALI), Department of Agriculture (DOA) and Department of Agricultural Research (DAR) and provided technical guidance based on the survey results.

We provided technical guidance on fertilization methods effective for different soil types as to improve agricultural productivity. To improve quality, we provided technical guidance on pest control and use of pesticides.

We found that the amount of fertilization was small in most production fields in black sesame cultivation in Myanmar. This is to avoid the risk of soil nutrition leaking away depending on the timing of rainfall. We proposed and instructed a fertilization method effective for each soil type to minimize risk and improve productivity. When investigating the current situation of soil and soil management, we instructed extension officers on site and improved their skills. We created graphic cards to explain fertilization methods by the soil type and compost making using livestock manure and a crop residues so that it would be helpful for extension officers to instruct farmers on site. Detailed investigation of soil layers, clarification of nourishing water transfer in soil layers, verification of reality and effects of additional fertilization and foliar application and verification of reality and effects of compost production and fertilization in the future will lead to establishment of a more reliable and stable high-yield cultivation method. We expect technologies we instructed in this project is used continuously in the future and leads to improved productivity of black sesame in Myanmar.

Though sesame exporters, researchers and extension officers recognize pesticide residue as a serious problem, pesticides are used improperly at the producer level. At the root of the "pesticide problem", there is the "insect pest problem". Without understanding the occurrence and damage situation of insect pests, the pesticide problem cannot be solved. It is necessary to survey occurrence of insect pests every year and establish effective control methods depending on the result of the survey. Long-term efforts must be made by extension officers and researchers. Therefore, we provided on-the-job instruction for extension officers and instructed a pest investigation method when we surveyed pests at farmers. As to insect pest control, we guided an idea of IPM (Integrated Pest Management) chemical control method, physical control method, ecological (cultural) control method and biological control method combined in addition to pesticides. The pest control and pesticide manual defines the identification of pests and natural

enemies and IPM. This manual has been created for researchers and extension officers to use easily. As annual investigation is required for occurrence of pests, we expect the DOA and DAR would continue to collect knowledge using the investigation methods learned.

In workshops where technical guidance was shared widely and the content of the manual was deliberated, 90% of the contents were understood and we obtained feedback that all participants would like to use and extend provided techniques.

2. Remaining Issues

Meanwhile, others issues black sesame farmers faced were clarified during the implementation of this project. Many involved in supply chains see quality-damage at the time of postharvest as one of the biggest issue. Thus detailed investigation of current situations are requires. Many farmers directly pile up harvested sesame in the field to dry the sesame. It seems humidity increases while sesame is piled up, which leads to an increase in the acid value. Increase of acid value deteriorates the taste and inhibit satisfying requirements at the time of export. It is a serious problem for supplier of sesame and influences stable supply of sesame to Japan. First, it is necessary to confirm whether or not a drying method and an increase in acid value are causally related in cooperation with the DOA and DAR and deliberate and instruct a better postharvest processing method based on scientific grounds.

In addition, quality seeds are seldom distributed and farmers rely on self-seed. Even sesame seeds with variety names have frequently different characteristics. Quality seeds of varieties required by the market must be produced. However, as Myanmar government prioritize yield increase, consumers' needs for the fragrance and flavor of sesame are often overlooked. As the DAR etc. aims at the development and recommendation of high-yield varieties, it is also important to see if their sesame seeds match the preference required by consumers. Development of market-oriented varieties and production of market-oriented seeds are required.

Making a mechanism is one of the major issues. Prices must be differentiated depending on quality. Traceability must be strengthened and farmers that produce flavorful and high-quality sesame are fairly compensated for their efforts.

As sesame seeds produced in Myanmar are in high demand in East Asian countries such as Japan and contribute to increased farm incomes as a cash crop, Myanmar government, private companies and donors put emphasis on the crop. Information on what efforts each parties are making must be shared and conveyed so that on-site extension officers and farmers do not get confusing. It is desirable that efforts by support organizations create a synergy effect and farmers' income increase, which lead to the development of the food industry in Myanmar.

ANNEX

Workshop on Agricultural Productivity and Quality Improvement of Sesame in Magway Region

(Magway)

Date	4 August 2017 (Friday)
Time	09:00 - 12:35
Venue	Meeting Room, DOA Regional Office, Magway

Agenda

MC:	U Soe Win Maung (JAICAF Mission Coordinator)
Interpreter:	Daw Su Pyi Son (Japanese/English-Myanmar)
09:00 – 09:15	Opening Address by Minister of Magway District
09:15 – 09:20	Background of the workshop by JAICAF (U Soe Win Maung)
09:20 - 09:50	Current practice and problems of plant protection and fertilizer management in sesame Production. by Daw Maw Maw Win, Assistant Director, DOA Regional Office, Magway
09:50 - 10:20	How to approach the issues on soil management for better production of sesame by Dr. Masaaki Suzuki, Technical Advisor, JAICAF (Expert of soils and fertilizers)
10:20 - 10:30	-- Tea Break --
10:30 - 11:00	Production of new sesame varieties and Pure seed program by Daw Hla Hla Win, Director, DAR Magway Oil seed Crops Research Center
11:00 - 11:30	Sesame insect pests and natural enemies in Myanmar ~ Insect occurrences and management methods ~ by Dr. Azusa Fujiie, Technical Advisor, JAICAF (Expert of insect pest)
11:30 – 12:30	General Discussion
12:30 - 12:35	Closing Remarks by U Khin Maung Win, DOA Regional Officer, Magway
12:35 -	Photo session and Lunch

(END)

Workshop on Agricultural Productivity and Quality Improvement of Sesame in Magway Region

(Nay Pyi Taw)

Date	7 August 2017 (Monday)
Time	10:00 - 12:10
Venue	Meeting Room, DOA Headquarters, MOALI, Nay Pyi Taw

Agenda

MC:	U Soe Win Maung (JAICAF Mission Coordinator)
Interpreter:	Daw Su Pyi Son (Japanese/English-Myanmar)
10:00 – 10:05	Opening Announcement by Dr Ye Tint Tun, Director General, DOA, MOALI
10:05 - 10:10	Background of the workshop by JAICAF(U Soe Win Muang)
10:10 - 10:35	Current practice and problems of plant protection and fertilizer management in sesame Production. by Daw Maw Maw Win, Assistant Director, DOA Regional Office, Magway
10:35 - 11:00	How to approach the issues on soil management for better production of sesame by Dr Masaaki Suzuki, Technical Advisor, JAICAF (Expert of soils and fertilizers)
11:00 - 11:25	Production of new sesame varieties and Pure seed program by Daw Maw Maw Thi, Assistant Research Officer, DAR Magway Oil seed Crops Research Center
11:25 - 11:50	Sesame insect pests and natural enemies in Myanmar ~ Insect occurrences and management methods ~ by Dr Azusa Fujiie, Technical Advisor, JAICAF (Expert of insect pest)
11:50 - 12:10	General Discussion
12:10 - 12:20	Closing Remarks by Dr Ye Tint Tun, Director General, DOA, MOALI
12:20 -	Photo session and Lunch

(END)

How to approach the issues on soil management for better production of sesame

Workshop in Myanmar

Magway & Nay Pyi Taw

4th and 7th Aug. 2017

Masaaki Suzuki, Technical Advisor,

JAICAF (Expert of soils and fertilizers)

Sesame field in Magway and threshing in Pwintbyu

Background

- Black sesame of Myanmar is popular in Japan due to its high quality
- Magway is one of the most important district for production of black sesame in the country
- Major constraints of sesame production in Magway are: water, soil, insect/pest, etc.
- Problems raised by consumers/buyers are residual pesticide and fatty acids

Black sesame brought to warehouse

Sesame cultivation in Magway

- In **rain-fed area**, mostly upland and **sandy soil**, is planted 2 crops, namely **sesame(from May to August) and groundnut/greengram.**
- **Lowland** as Pwintbyu, mostly **clay soil**, and irrigated area is planted 3 crops, namely **sesame(from April to July), rice and chick pea.**

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Constraints of sesame production in Magway

- **Climate:** CDZ: Central Dry Zone
- **Soil:**
  - **Sandy soils**: in plateau, rain fed agriculture
  - **Clay soils**: in lowland, river basin
- **Varieties of sesame**:
  - Sinyadanar3, Sinyadanar14(Black sesame), Local variety such as Science black (Teppan)
- **Cultivation technologies**:
  - Fertilizer application method
  - Maintenance and improvement of soil fertility

5/24

Comparison of fertilizer use and yield of sesame between Magway & Japan

- Fertilizer: Farmer in Magway use 1/5-10 amount of NPK fertilizer compared with Japanese farmer.
- Yield: In Magway districts yields varies from 5-15 baskets/ac (123-368kg/ac), while average yield is 11-16 baskets (280-400kg/ac) in Japan. 1 basket=24.5kg of sesame

Sesame can grow with less fertilizers and much resistant to drought compared with other crops. Weather, soil, varieties, acreage, cultivation methods are much different between Magway and Japan, though;

- Problem----→ Why the yield variation is big among farmers in Myanmar even under the similar field conditions such as rain fall and soil?
- Are there any difference of fertilizer application method, or soil conditions?

8/24

Sandy soils in Magway and Clay soils in Pwintbyu

6/24

Soil characteristics

- **Characteristic profile of Clay soil in Pwintbyu**
- Surface color is black. Soil texture is Heavy Clay, and no change up to the depth of 60cm or deeper. →Fertile soil and suitable for rice but soil management is not easy due to sticky heavy clay.

11/24

Fertilizer application method

- Magway;
- Farmer A: Complexed fertilizer, N:P:K=15:15:15, 50kg/ac as basal application, which is equivalent to N:P2O5:K2O=7.5kg:7.5kg:7.5kg, and 100kg CaSO4
- Farmer B: N:P:K=15:15:15, 25kg/ac as basal application and 25kg as top dressing, which is equivalent to N:P2O5:K2O=7.5kg:7.5kg:7.5kg/ac in total, and apply 7.7kg nitrogen as top dressing by urea.
- Farmer C: Mixed fertilizer as basal application N:P2O5:K2O=4.4:2.0:2.3kg/ac
- Farmer D: No basal application, but top dressing of NPK with minor elements.
- Japan; N:P2O5:K2O=32-48:40:32-40kg/ac as basal application, and N:K =12kg :12kg, respectively as top dressing.
- Fertilization practice is standardized in Japan (basal application and top dressing) but fertilization method varies from farmer to farmer in Magway

9/24

Soil profile of sandy soil, water and wind erosion

Soil characteristics

- **Characteristic profile of Sandy soil in Magway**

1. Surface color is gray to reddish. →Red color is iron.
2. **Soil texture is sandy and different in the depth of soil profile.** Some fields increase clay content along with depth, but in many field, sandy soil layer are more than 1 meter with no particular change except for color due to organic matter. →Dark color is made by organic matter.
3. **Soil moisture changes from top to subsoils gradually from moist to wet**, and it is clear if the profile has clay layer such as Clay Loam.
4. **The area in a field with good growth had CL layer at the depth of 50cm**, but It was deeper in poor growth area. →How to hold and supply plant nutrients and water may be concerning to the growth.
5. **Soil pH is neutral (7) to alkaline(9).**
6. **Susceptible to wind and water erosion** →Leguminous plant such as *Gliricidia Sepium* would be effective

10/24

Effective use of organic materials

- **Animal dung:** Cattle and goat dung are used directly or as compost material. Composting is common practice in Magway.

→Use as much as possible(8t/ac is recommended as compost in Japan) to increase nutrients such as N,P, K and minor elements and soil organic matter increase a capacity of soil to hold water and nutrients.

Soil test and *Gliricidia Sepium* against wind erosion

Compost and farm yard manure

Effective use of organic materials

- **Plant residue:** Sesame stem is burned in the field(in Pwintbyu), but it is used as a compost material (EM - Bokashi) in Magway. Crop residue of ground nuts is used for animal feed and for compost material. (Magway).

→Composting is good practice. Ash contain P and K, so that it can be used as fertilizer. Available weeds along the border, canal or road can be used as material for compost. Cleaning environment of the field and house is important from insects, pests, snake bite and sanitary aspect.

How to apply fertilizer to sesame appropriately

- Sandy soils

1. N: 50% for basal application, 50% for top dressing by urea for 2 times.

   P: All for basal application.

   K: 50% for basal application, 50% for top dressing by K2SO4 for 2 times.

   S: CaSO4 for basal application →Good for groundnut

   Minor elements: such as Fe, Mn, Cu, Zn, B, Mo are as top dressing by spray

   If mixed fertilizer is used, P and K would be lower. For example;15-8-8.

   Top dressing of N and K should be applied to poorly growing area to catch up.

2. Generally, top dressing could be recommended for sandy soils.

- Clay soils in lowland

  Basal application is acceptable due to no movement of fertilizer as in sandy soil, and no much risk for water problem. Increase fertilizer level if possible.

Planting density and inter-row spacing

- In Magway sandy soil area.

  Spacing:10-15cm x 35cm →76,000-114,000 plants/ac

  In Japan; 10-15cm x 45cm→60,000-88,000 plants/ac

- In Pwintbyu clay soil area.

  Plant density seems to be high due to broad casting

- Effects of spacing: → Enough space between lows is important for growth and branching, and soil management such as weeding and top dressing.

Fertilizers and micronutrient fertilizer

Inter –row spacing

Sandy soil in Magway (left) & Clay soil in Pwintbyu

Summary

- Sesame production in Magway is made in Central Dry Zone. The soil is sandy and the land is gently undulating. The production is largely depending on rain fall and soil-moisture.
- Level of fertilizer application is generally low. The soil is neutral to alkali reaction, so that availability of some micronutrients such as iron, zinc, manganese may decrease as well as boron. Therefore supply of micronutrients as foliar spray may be effective.
- Flat soil surface have different depth of sand in the soil profile. Some soils have clay-rich layer where water and nutrients may be retained. Movement of soil moisture is largely affected with this layer. It is important to pay more attention to the soil profile for both farmer and researcher.

Fertilizers and sprayer

$CaSO_4 \cdot 2H_2O$ Urea Sprayer

continued

- I dry zone, moisture go down first after rainfall, but it go up to the soil surface together with soluble nutrients when evaporation of moisture start from the soil surface. However, the location where sand layer is very deep, nutrition loss may occur.
- Therefore, sprit application of fertilizers as top dressing is effective and recommended.
- Sesame is highly resistant to drought and it can grow in infertile soil. Nutrition uptake from the field as seeds is small if plant residue is returned either as ash or as compost.
- To increase soil organic matter has positive effects not only to supply nutrients but also increase capacity to retain nutrients and moisture in the plough layer.
- By careful management of the field is important for every farmer to get higher yield.

Drying methods after harvest

- **Piling in Myanmar is causing problems of fatty acid accumulation.**
- **Some farmer in Japan are using stand as shown here (Left).**
- Japanese method Myanmar method
  Standing only Piling + Standing

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Investigated sesame stages

* We carried out field investigations at each sesame stage. Insects and diseases were investigated on sesame plants.
* We also investigated insects on weeds.

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Sesame insect pests and natural enemies in Myanmar

=Insect occurrences and management methods=

August, 2017

JAICAF

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Contents

1. Investigation points
2. Investigation methods
3. Major sesame pests
4. Major natural enemies
5. Pest management methods
6. Targeting IPM
7. Proposals

Attached data

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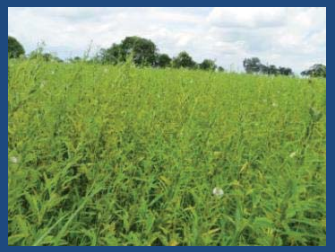
Extensive sesame (*Sesamum indicum*) fields in Myanmar



* Japan is importing sesame from Myanmar etc., because sesame plants are not widely cultivated in Japan (cultivation areas: several hundreds ha).
* This crop is also used for preserving and propagating native natural enemies in Japan.

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2. Investigation methods

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1. Investigation points

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(1) Sweeping method

We swept 20 times with an insect net, and investigated caught insects.

(2) Direct counting method

We counted insects directly, and caught insects. Disease plants were also counted directly.

(3) Sticky trap method

We set yellow sticky traps in sesame fields for collecting small insects

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40 points (fields)

Magway Township
(Magway District, Magway Region)
and
Pwintbyu Township
(Minbu District, Magway Region)

June and July, 2017

11/64

Virus and aphids

Reference
Green peach aphid
(adult: vector, probably)

* Virus disease plants have no seed pods, so the yield decrease of sesame occur.
* But we have little information on this virus and aphids.

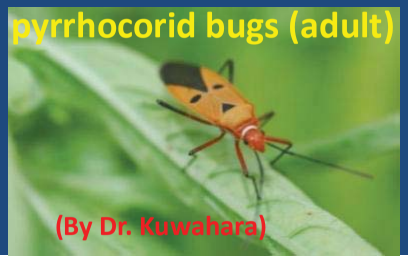
9/64

3. Major sesame pests

12/64

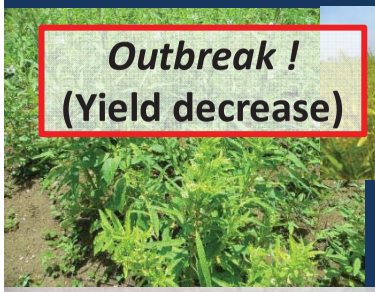
Stink bugs, pyrrhocorid bugs and lygaeid bugs

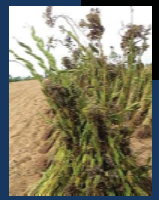
A kind of pyrrhocorid bugs (adult)



10/64

Phytoplasma (Micoplasma) and leaf hoppers





Sesamun jassid
(adult: vector)

Maximum disease plants = 47%

15/64

Owlet moths

(larvae)

* Several owlet moths such as cotton bollworm, common cutworms, cutworms, etc. can violently damage sesame plants.

13/64

Pyralid moths

Damaged leaves

Sesamum leaf roller (larvae)

16/64

Scarabs

Sesumum bkack beetle (larvae)

* Scarabs larvae can violently damage sesame roots.

14/64

Tiger moths

(By Dr. Kuwahara)

Common hairy caterpillar (larva)

19/64

4. Major natural enemies

Natural enemies are predators and parasites which attack insect pests.

In fields insect pests are controlled by natural enemies.

17/64

Sphinx moths (death's head etc.)

Reference
A kind of sphinx moths collected in Japan

20/64

Parasitic wasps

Reference
A kind of Braconidae

* Parasitic wasps such as Eulophidae and Braconidae were very important natural enemies.

18/64

Small insects trapped by yellow sticky traps

Reference:
aphid (adult)

* Leaf hoppers were trapped, but aphids which were attracted by yellow were not trapped in June and July, 2017.

23/64

Earwigs

* Various kinds of natural enemies are in fields.

Reference: Several natural enemies

21/64

Dragonflies

* Dragonflies eat various insect pests.

24/64

5. Pest management methods

22/64

Leaf bugs, flower bugs and big-eyed bugs (Predatory bugs)

* In Myanmar we observed small predatory bugs such as Miridae, Anthocoridae and Geocoridae.
* In Japan we can often observe tobacco leaf bugs (*Nesisiocoris tenuis*) on sesame plants.

27/64

Main sesame insecticides in Myanmar

Component name	Trade name	Characteristic
Deltamethrin 2.5%EC	Decis	Synthetic pyrethroid insecticide
Diazinon 40.0%EC	Diazinon	Organophosphorus insecticide
Dimethoate 40.0%EC	Dimathoate	Organophosphorus insecticide

*In Myanmar registered pesticides (agrochemicals) are 2,748 in 2015.

Pest control methods

Control method	Main technology
Chemical method	agrochemicals (Pesticides).
Physical method	catching and killing. quarantine. treatment of light, color and heat.
Ecological method / Cultural method	crop rotation. mixed cropping. intercroping. implantation. ploughing. cleaning. Barrier crops, enemy plants. manuring practice. resistant varieties.
Biological method	natural enemy formulations. natice natural ememies. pheromon formulations. genetic control.

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fenitrothion(フェニトロチオン)50.0%EC	Sumithion	organophosphorus insecticide(有機リン系殺虫剤)
fenpropathrin(フェンプロパトリン)10.0%EC	Danitol	synthetic pyrethroid compound insecticide(合成ピレスロイド系殺虫剤)
imidacloprid(イミダクロプリド)70.0% D and 70%WP	Gaucho and DOZER	neonicotinoid insecticide(ネオニコチノイド系殺虫剤)
malathion(マラチオン)50.0%EC *	unknown	> organophosphorus insecticide(有機リン系殺虫剤)
phenthoate(フェントエート)50.0%EC *	unknown	> organophosphorus insecticide(有機リン系殺虫剤)

(Insecticides were quoted from the literature of Plant Protection Division, DOA, Myanmar)

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Chemical control methods

Dilution ratios and dosages of pesticides for proper concentration

31/64

Dilution	Dosage of agrochemicals (ml or g)		
	Quantity of water 1L(1,000ml)	Quantity of water 10L(10,000ml)	Quantity of water 100L(100,000ml)
100	10	100	1,000
200	5	50	500
250	4	40	400
500	2	20	200
1,000	1	10	100
2,000	0.5	5	50
2,500	0.4	4	40
5,000	0.2	2	20
10,000	0.1	1	10

(JAICAF, 2015)

Permitted insecticides to sesame insect pests in Japan

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Component name	Characteristic
cypermethrin(シペルメトリン) 10.0% EC	> synsetic pyrethroid insecticide(合成ピレスロイド系殺虫剤) > aphids
saccharified reduced starch(還元澱粉糖化物) 60.0% SL	> polysaccharides insecticide(多糖類殺虫剤) > aphids
chlorantraniliprore(クロラントラニリプロール) 5.0% WP	> diamide insecticide(ジアミド系殺虫剤) > larvae of lepidopteran insect pests
diazinon(ダイアジノン) 40.0% GR	> organophosphorus insecticide(有機リン系殺虫剤) > aphids, larvae of lepidopteran insect pests (contain cutworms), thrips, scarabs, thrips, etc. > the abailable insecticide to sesame in Japan

* In Japan, we have only four insecticides, which are registered on sesame, although we have above 4,000 pesticides. Sesame is a minor crop.

Physical control methods

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Proper using of proper pesticides !!

30/64

> Buy proper pesticides from legal channels based on the law!

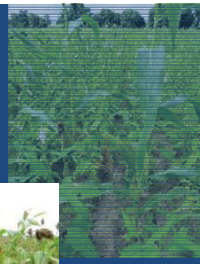
> Follow the directions of labels !

- Targeted crops and pests !
- Season and frequency of sprays !
- Proper concentrations !

> Don't sell sesame seeds, which are treated with pesticides, as sesame products !

* These are very important for safety (residual pesticides etc.), cost reduction, insecticidal efficacy and chemical injury prevention.

(1) Barrier crops such as sorgos, maize and millet protect sesame plants against insect pests.



(2) Suitable management of organic matter in soil of fields is important, because organic rich soil attracts the adult of scarabs.

(1) Ridding weeds and disease (virus or phytoplasma) plants

(2) Net (5mm mesh) covers on harvested sesame plants for controlling inset pests

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Biological control methods

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Ecological (Cultural) control methods

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6. Targeting IPM

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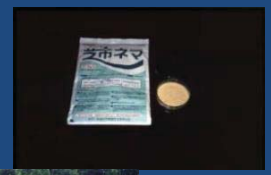
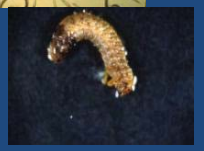
(1) Bio-insecticide (Natural enemy formulations)


* We developed the formulation of natural enemy nematodes for controlling scarabs in Japan.
* Many kinds of natural enemies (wasps, bugs, mites, nematodes, etc.) formulations are on the market.

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> Globally, integrated pest management (IPM) has been recognized. IPM is essential to plant protection all over the world.

> IPM have been extended in the horticulture under structure conditions. We should extend in the horticulture under field conditions.

> The technology on IPM should be developed based on the agricultural condition in each country.

> IPM is evolving from conventional IPM into bio-intensive IPM（Dufour, 2011 etc.).

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(2) Native natural enemies



Reference
Parasitic wasps

* Native natural enemies are preserved an propagated by the management of vegetation (crops and weeds) as their habitats in fields.
* In the near future we would like to use natural enemies for controlling sesame insect pests.

(1) Sesame pests (insect pests and diseases) in Myanmar

> The sesame pest problem is serious in Myanmar. We should understand that the pest problem causes the residual pesticide problem.

> The ecological information on major sesame pests is essential to solve the pest problem.

> We should investigate the seasonal change of major sesame pests every year, because pest occurrences differ in each year.

IPM system in Japan

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

(Extracted from the Ministry of Agriculture, Forestry and Fisheries, in 2005)

(2) At the early and middle stages: disease such as phytoplasma transmitted by insect pests

> The outbreak of phytoplasma disease is occurring in many fields of Myanmar.

> Sesame plants are infected with the disease at the early and middle stages.

> Pathogenic microbes, phytoplasma, are carried by leaf hoppers (jassid). So controls are important at the early stage.

7. Proposals

＊ We will present the manual for sesame pests in Myanmar at an early date.

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> Scarab larvae severely eat sesame roots in soil. Organophosphorus insecticides (granule type) are efficacious. The bio-insecticide like entomopathgenic nematodes is on the market.

> The soil with rich organic matters promote the egg-laying of scarab adults.

> At the middle and late stages, bugs and *Rhizoctonia* diseases occur, and moreover, the disease symptoms caused by phytoplasma and virus are actualized.

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> Permeability insecticides like organophosphorus are efficacious. Seed coating with pesticides is also efficacious as a chemical method.

> We should rid disease plants from fields for protecting the spread of infections as a physical method.

> Barrier crops, such as sorgo, maize and millet plants, protect sesame plants against the come flying of insect pests as an ecological and cultural method.

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(4) After harvesting: The deterioration of sesame, various pests such as bugs and insecticide residue

> Long drying terms after harvest cause various problems. So the right time for harvesting is very important.

> We consider that the pest damage after harvesting is limitative. Almost pests occur at the cultivation stage.

> Never spray insecticides after harvest.

> Net covers on harvested sesame plants is probably effective for protecting the damage of insect pests (5mm mesh for bugs).

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(3) At the middle and late stages: Lepidopteran insect pests with a chewing mouth

> These insect pests occur at the middle and late stages.

> Synthetic pyrethroid, organophosphorus and macrolide insecticides are efficacious as a chemical method, but we should refrain from spraying of pesticides at the late stage.

> Capture and destroy are effective as a physical method. The using of bio-insecticides and native natural enemies are desired in the near future.

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Attached data

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Acknowledgement

Ministry of agriculture,
livestock and irrigation, Myanmar

Department of agriculture (DOA), Head office
DOA Regional office, Magway
Department of agricultural research (DAR), Head office
DAR Magway oil seed crop research center

Sesame farmers and pesticide stores

* This project, which was aided by the Ministry of agriculture, forestry and fisheries, Japan, was carried out by JAICAF.

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Investigation points

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Sesame insect pests and natural enemies in Myanmar

=Insect occurrences and management methods=

Dr. Masahiko KUWAHARA provided valuable suggestions about pesticides for us.

July, 2017

JAICAF

Dr. Azusa FUJIIE has the responsibility for the content of this file.

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Major sesame insect pests

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Investigation points (June, 2017)

Abbreviation	Point-name	Investigation date	Remarks
#1	Kyan Su Village, Pwintbyu TS	24-Jun	In drying (stand) in the outside of a field. Sesame investigation
#2	Kyan Su Village, Pwintbyu TS	24-Jun	In sesame cultivation. Sesame and weeds investigations
#3	Kyan Su Village, Pwintbyu TS	24-Jun	In field drying (stand). Sesame and weeds investigations
#4	San Pya Village, Pwintbyu TS	24-Jun	In sesame cultivation. Sesame and weeds investigations. Yellow sticky trap installation
#5	San Pya Village, Pwintbyu TS	24-Jun	In field drying (pile). Seed investigation. Yellow sticky trap installation
#6	San Pya Village, Pwintbyu TS	24-Jun	In sesame cultivation. Sesame and weeds investigations
#7	San Pya Village, Pwintbyu TS	24-Jun	In sesame cultivation. Sesame and weeds investigations
#8	San Magyi Village, Magway TS	25-Jun	In sesame cultivation. Early stage. Sesame investigations
#9	San Magyi Village, Magway TS	25-Jun	In sesame cultivation. Sesame investigations
#10	San Magyi Village, Magway TS	25-Jun	In sesame cultivation. Sesame and weeds investigations
#11	San Magyi Village, Magway TS	25-Jun	In sesame cultivation. Sesame and weeds investigations
#12	Aloe Bo Village, Magway TS	25-Jun	In sesame cultivation. Eary stage. Sesame investigations
#13	Aloe Bo Village, Magway TS	25-Jun	In sesame cultivation. Sesame investigations
#14	San Pya Village, Pwintbyu TS	26-Jun	In sesame cultivation. Sesame investigations
#15	San Pya Village, Pwintbyu TS	26-Jun	In field drying (pile). Sesami investigation
#16	San Pya Village, Pwintbyu TS	26-Jun	In sesame cultivation. Sesame investigations
#17	Con Ywor Lay Village, Magway TS	27-Jun	In sesame cultivation. Eary stage. Sesame and weeds investigations
#18	Con Ywor Lay Village, Magway TS	27-Jun	In sesame cultivation. Sesame investigations
#19	Con Ywor Lay Village, Magway TS	27-Jun	In sesame cultivation. Sesame investigations
#20	Con Ywor Lay Village, Magway TS	27-Jun	In sesame cultivation. Eary stage. Sesame and weeds investigations

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Insect pests on sesame (June, 2017)

Abbreviation (記号)	Aphididae (アブラムシ科)	Pentatomidae (カメムシ科) Lygaeidae (ナガカメムシ科) Pyrrhocoridae (ホシカメムシ科)	Cicadellidae (ヨコバイ科)	Scarabadidae (コガネムシ科)	Noctuidae (ヤガ科) budworms, cutworms, etc. (ヨトウムシ類、ネキリムシ類等)	Sphingidae (スズメガ科)	Pyralidae (メイガ科)	Arcitiidae (ヒトリガ科)
#1	0	4	0	0	2	0	0	0
#2	0	2	0	0	0	0	0	0
#3	0	0	5	0	0	0	0	0
#4	0	0	0	0	0	0	0	1
#5	0	1	0 (Mycoplasma 1%)	0	0	0	0	0
#6	0	0	3	0	0	0	0	0
#7	0	1	2	0	0	0	0	0
#8	0 (Virus 3%)	1	5	2	0	0	2	0
#9	0	0	0	0	0	0	1	0
#10	0 (Virus 4%)	2	0 (Mycoplasma 14%)	0	0	0	0	0
#11	0	1	0	0	0	0	0	0
#12	0	0	0	0	0	0	0	0
#13	0 (Virus 2%)	0	1 (Mycoplasma 15%)	8	0	0	0	0
#14	0	1	7 (Mycoplasma 1%)	0	0	0	0	0
#15	0	0	0	0	0	0	0	1
#16	0	0	0	0	0	0	0	0
#17	0	1	3	0	0	0	0	0
#18	0	0	3	0	0	0	0	0
#19	0	0	1 (Mycoplasma 1%)	0	0	0	0	0
#20	0	1	1	0	0	0	0	0
#4 Y trap	0	0	3					
#4 Y trap	0	0	7					
#5 Y trap	0	0	10					
#5 Y trap	0	0	11					

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Investigation points (July, 2017)

Abbreviation	Point-name	Investigation date	Remarks
#1	San Magyi Village, Magway TS	27-Jul	In sesame cultivation. Sesame and weeds investigations
#2	San Magyi Village, Magway TS	27-Jul	In sesame cultivation. Sesame and weeds investigations
#3	San Magyi Village, Magway TS	27-Jul	In sesame cultivation. Sesame investigations
#4	San Magyi Village, Magway TS	27-Jul	In sesame cultivation. Sesame and weeds investigations
#5	San Magyi Village, Magway TS	27-Jul	In sesame cultivation. Sesame and weeds investigations
#6	Aloe Bo Village, Magway TS	27-Jul	In sesame cultivation. Sesame investigations
#7	Aloe Bo Village, Magway TS	27-Jul	In sesame cultivation. Sesame investigations
#8	Aloe Bo Village, Magway TS	27-Jul	In field drying (stand). Sesame and weeds investigations
#9	CanYwor Lay Village, Magway TS	28-Jul	In sesame cultivation. Sesame investigations. Yellow sticky trap installation
#10	CanYwor Lay Village, Magway TS	28-Jul	In sesame cultivation. Sesame investigations. Yellow sticky trap installation
#11	CanYwor Lay Village, Magway TS	28-Jul	In sesame cultivation. Sesame and weeds investigations
#12	CanYwor Lay Village, Magway TS	28-Jul	In sesame cultivation. Sesame investigations
#13	CanYwor Lay Village, Magway TS	28-Jul	In sesame cultivation. Sesame investigations
#14	CanYwor Lay Village, Magway TS	28-Jul	In sesame cultivation. Sesame investigations
#15	CanYwor Lay Village, Magway TS	28-Jul	In sesame cultivation. Sesame investigations
#16	San Pya Village, Pwintpyu TS	28-Jul	In sesame cultivation. Sesame investigations. Yellow sticky trap installation
#17	San Pya Village, Pwintpyu TS	28-Jul	In sesame cultivation. Sesame investigations. Yellow sticky trap installation
#18	San Pya Village, Pwintpyu TS	28-Jul	In field drying (pile). Seed investigation.
#19	San Pya Village, Pwintpyu TS	28-Jul	In sesame cultivation. Sesame investigations
#20	San Pya Village, Pwintpyu TS	28-Jul	In sesame cultivation. Sesame investigations

Insect pests on weeds (July, 2017)

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Abbreviation (記号)	Aphididae (アブラムシ科)	Pentatomidae (カメムシ科) Lygaeidae (ナガカメムシ科) Pyrhocoridae (ホシカメムシ科)	Cicadellidae (ヨコバイ科)	Scarabaidae (コガネムシ科)	Noctuidae (ヤガ科) budworms, cutworms, etc. (ヨトウムシ類、ネキリムシ類等)	Sphingidae (スズメガ科)	Pyralidae (メイガ科)	Arcitiidae (ヒトリガ科)
#1	0	1	1	0	3	1	0	0
#2	0	0	2	0	0	0	0	0
#4	0	0	1	0	0	0	0	0
#5	0	0	0	0	0	0	0	0
#8	0	1	3	0	0	0	0	0
#11	0	2	0	0	0	0	0	0
#20	0	1	0	0	0	0	0	0

Insect pests on sesame (July, 2017)

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Abbreviation (記号)	Aphididae (アブラムシ科)	Pentatomidae (カメムシ科) Lygaeidae (ナガカメムシ科) Pyrrhocoridae (ホシカメムシ科)	Cicadellidae (ヨコバイ科)	Scarabaidae (コガネムシ科)	Noctuidae (ヤガ科) budworms, cutworms, etc (ヨトウムシ類、ネキリムシ類等)	Sphingidae (スズメガ科)	Pyralidae (メイガ科)	Arcitiidae (ヒトリガ科)
#1	0 (Virus 1%)	1	6(MLO 11%)	0	0	0	0	0
#2	0 (0%)	0	7(MLO 9%)	0	0	0	0	0
#3	0 (0%)	0	3(MLO 5%)	0	1	0	0	0
#4	0 (0%)	0	3(MLO 7%)	0	0	0	0	0
#5	0 (0%)	0	2(MLO 2%)	0	0	0	0	0
#6	0 (0%)	0	4(MLO 8%)	0	0	0	0	0
#7	0 (Virus 1%)	6	0(MLO 3%)	0	0	0	0	0
#8	0	0	0	0	0	0	0	0
#9	0 (0%)	0	2(MLO 10%)	0	0	0	0	0
#10	0 (0%)	0	0(MLO 41%)	0	0	0	0	0
#11	0 (1.0%)	1	1(MLO 10%)	0	0	0	0	0
#12	0 (0%)	0	1(MLO 8%)	0	0	0	0	0
#13	0 (0%)	0	0(MLO 4%)	0	0	0	0	0
#14	0 (0%)	2	1(MLO 47%)	0	0	0	0	0
#15	0 (0%)	0	1(MLO 3%)	0	0	0	0	0
#16	0 (0%)	1	1(MLO 33%)	0	0	0	0	0
#17	0 (0%)	0	0(MLO 25%)	0	0	0	0	0
#18	0	0	0	0	0	0	0	0
#19	0 (0%)	4	(MLO 0%)	0	0	0	0	0
#20	0 (0%)	1	(MLO 0%)	0	0	0	0	0
#10 Y trap	0	0	17					
#12 Y trap	0	0	6					
#16 Y trap	0	0	2					
#17 Y trap	0	1	1					

Major natural enemies

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Insect pests on weeds (June, 2017)

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Abbreviation (記号)	Aphididae (アブラムシ科)	Pentatomidae (カメムシ科) Lygaeidae (ナガカメムシ科) Pyrhocoridae (ホシカメムシ科)	Cicadellidae (ヨコバイ科)	Scarabaidae (コガネムシ科)	Noctuidae (ヤガ科) budworms, cutworms, etc. (ヨトウムシ類、ネキリムシ類等)	Sphingidae (スズメガ科)	Pyralidae (メイガ科)	Arcitiidae (ヒトリガ科)
#2	0	0	4	0	0	0	0	
#3	0	0	3	0	0	0	0	0
#4	0	3	0	0	0	0	0	0
#6	0	2	3	0	0	0	0	0
#7	0	0	0	0	0	0	0	0
#10	0	0	0	0	0	0	0	0
#11	0	0	2	0	0	0	0	0
#17		0	0					
#20		2	8					

*** Weedy areas are limited in sesame zones in Myanmar.**

Natural enemies on weeds (June, 2017)

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Abbreviation (記号)	Parasitic wasps (寄生蜂) Eulophidae (ヒメコバチ科) Braconidae (コマユバチ科) etc.	Coccinellidae (テントウムシ科)	Chrysopidae (クサカゲロウ科)	Predatory bugs (捕食性カメムシ類) Miridae (カスミカメムシ科) Anthocoridae (ハナカメムシ科) etc.	Reduviidae (サシガメ科)	Staphylinidae (ハネカクシ科)	Araneae (クモ目)	Other (その他)
#2	0	0	0	0	0	0	1	0
#3	0	0	0	0	0	0	0	0
#4	0	0	0	5	0	0	2	0
#6	1	0	0	0	0	0	0	0
#7	0	0	0	0	0	0	0	0
#10	0	0	0	0	0	0	0	0
#11	0	0	0	0	0	0	0	0
#17	0	0	0	0	0	0	0	0
#20	3	0	0	0	0	0	0	0

Natural enemies on sesame (June, 2017)

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Abbreviation (記号)	Parasitic wasps (寄生蜂) Eulophidae (ヒメコバチ科) Braconidae (コマユバチ科) etc.	Coccinellidae (テントウムシ科)	Predatory bugs (捕食性カメムシ類) Chrysopidae (クサカゲロウ科)	Miridae (カスミカメムシ科) Anthocoridae (ハナカメムシ科) etc.	Reduviidae (サシガメ科)	Staphylinidae (ハネカクシ科)	Araneae (クモ目)	Other (その他)	Remarks (備考)
#1	0	0	0	0	0	0	0	Earwig 1	Direct
#2	0	0	0	2	0	0	1	0	Sweeping
#3	0	0	1	3	0	0	1	0	Direct
#4	0	0	0	3	2	0	0	0	Swepping
#5	0	0	0	0	1	0	0	0	Direct
#6	0	0	0	0	0	0	0	0	Sweeping
#7	0	0	0	2	0	0	0	0	Sweeping
#8	0	0	0	0	0	0	0	0	Sweeping
#9	0	0	0	0	0	0	0	0	Sweeping
#10	0	0	0	0	0	0	0	0	Swepping
#11	0	0	0	0	0	0	0	0	Sweeping
#12	0	0	0	0	0	0	0	0	Sweeping
#13	2	0	0	0	0	0	0	0	Swepping
#14	0	0	0	3	0	0	0	0	Sweeping
#15	0	0	0	0	0	0	0	0	Direct
#16	2	0	0	0	0	0	2	0	Sweeping
#17	3	0	0	0	0	0	0	0	Sweeping
#18	0	0	0	0	0	0	0	0	Sweeping
#19	1	0	0	3	0	0	0	0	Sweeping
#20	2	0	0	0	0	0	1	0	Sweeping
#4 Y trap	0	0	0	2	0	0			
#4 Y trap	0	0	0	1	0	0			
#5 Y trap	0	0	0	1	0	0			
#5 Y trap	0	0	0	3	0	0			

Natural enemies on weeds (July, 2017)

64/64

Abbreviation (記号)	Parasitic wasps (寄生蜂) Eulophidae (ヒメコバチ科) Braconidae (コマユバチ科) etc.	Coccinellidae (テントウムシ科)	Chrysopidae (クサカゲロウ科)	Predatory bugs (捕食性カメムシ類) Miridae (カスミカメムシ科) Anthocoridae (ハナカメムシ科) etc.	Geocoridae (オオメカメムシ科)	Reduviidae (サシガメ科)	Staphylinidae (ハネカクシ科)	Araneae (クモ目) Thomisidae etc. (カニグモ科等)
#1	0	0	0	0	0	0	0	0
#2	0	0	0	0	0	0	0	0
#4	0	0	0	0	0	0	0	0
#5	0	0	0	0	0	0	0	0
#8	0	0	0	0	0	0	0	0
#11	0	0	0	0	0	0	0	0
#20	0	0	0	0	0	0	0	0

Natural enemies on sesame (July, 2017)

62/64

Abbreviation (記号)	Parasitic wasps (寄生蜂) Eulophidae (ヒメコバチ科) Braconidae (コマユバチ科) etc.	Coccinellidae (テントウムシ科)	Chrysopidae (クサカゲロウ科)	Predatory bugs (捕食性カメムシ類) Miridae (カスミカメムシ科) Anthocoridae (ハナカメムシ科) etc.	Geocoridae (オオメカメムシ科)	Reduviidae (サシガメ科)	Staphylinidae (ハネカクシ科)	Araneae (クモ目) Thomisidae etc. (カニグモ科等)
#1	1	0	0	0	0	0	0	0
#2	0	0	0	1	0	0	0	0
#3	0	0	0	0	0	0	0	0
#4	0	0	0	1	0	0	0	0
#5	0	0	0	0	0	0	0	2
#6	0	0	0	0	0	0	0	0
#7	0	0	0	0	0	0	0	2
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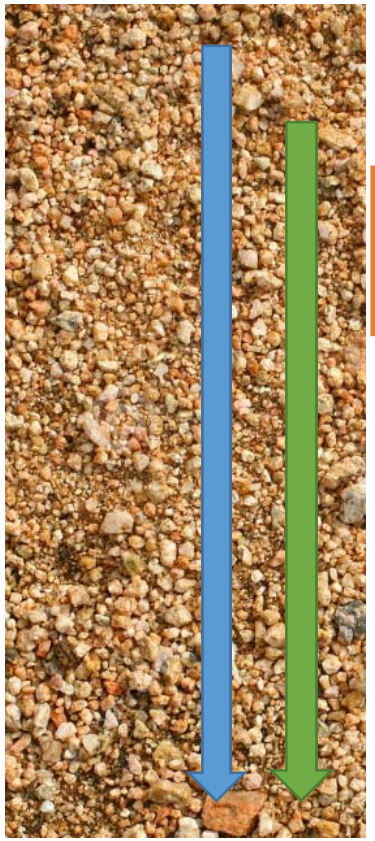
#11	0	0	0	0	0	0	0	0
#12	1	2	0	0	0	0	0	0
#13	0	0	0	0	0	0	0	0
#14	0	0	0	0	0	0	0	0
#15	0	0	0	1	0	0	0	0
#16	0	0	0	0	0	0	0	0
#17	0	0	0	0	0	0	0	0
#18	0	0	0	0	0	0	0	0
#19	0	3	0	0	0	0	0	3
#20	0	0	0	1	0	0	0	2
#10 Y trap	0	0	0	0	0	0	0	
#12 Y trap	1	0	0	0	0	0	0	
#16 Y trap	2	0	0	0	0	0	0	
#17 Y trap	1	0	0	0	0	0	0	

Soil Management

Sandy Soil

Soil particles are big and they don't stick together



Rain water drains easily

Nutrients drains easily

Basal fertilization is risky. Supplemental fertilization is effective.

Easy to plough
Easy to make ridge

Easy to weed

Stripe seeding/ hill seeding is recommended for weed control and supplemental fertilization

Clay Soil

Soil particles are small and they stick together tightly

Rain water stay

Nutrients stays

Basal fertilization is effective.

Difficult to plough
Difficult to make ridge

Difficult to weed

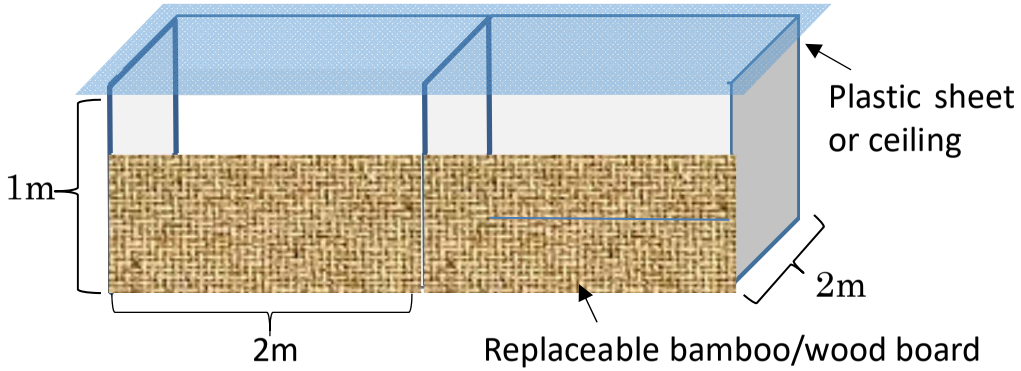
Stripe seeding/hill seeding is recommended.

Adding compost will improve soil for both soil types. Compost not only holds water and nutrients but also makes it easier for plants to utilize them. 8 tons of compost per acre is ideal.

Compost Making

1. Make compost pit

Cement floor, wall on three sides with replaceable bamboo/wood boards as doors



2. Gather materials

Collect livestock dungs and crop residues

3. Pile them up

1. Pile them up
2. Sprinkle water onto the pile
3. Make sure heat is generated inside the pile
4. Wait for 1 month to cool the heat

4. Turn over the compost pile

1. Mix the compost by putting outside layer inside and inside layer outside(Turning).
2. Repeat turning after one more month
3. Compost will be in black color
4. Ready to use

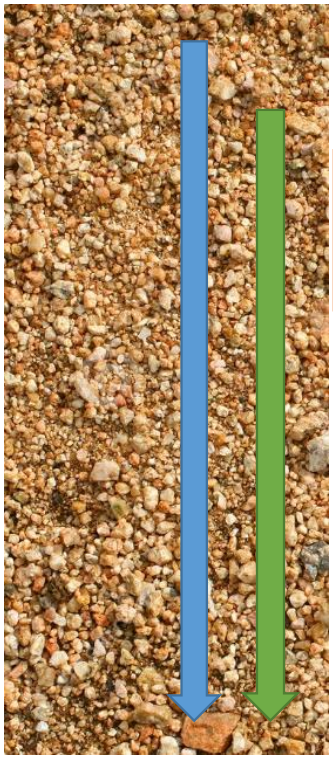
5. Use the compost

1. Mix well into the soil surface
2. 8 tons per acre is ideal
3. Any amount is better than nothing

မြေသားစီမံခန့်ခွဲခြင်း

သဲမြေ

မြေမှုန်များကြီးမားပြီး အချင်းချင်းစေးကပ်မှုမရှိ။



ရေအလွယ်တကူ ဆုံးရှုံးသည်။

အာဟာရများ အလွယ်တကူ ဆုံးရှုံးသည်။

အောက်ခြေပိုင်းမြေသြဇာကျွေးခြင်းသည် ဆုံးရှုံးမှုများသည်။ အပေါ်ယံထပ်ဆောင်းမြေသြဇာကျွေးခြင်းက အကျိုးရှိသည်။

ထွန်ယက်ရန်လွယ်ကူ
မြောင်းဖော်ရန်လွယ်ကူ

ပေါင်းနှုတ်ရန်လွယ်ကူ

ပေါင်းပင်ထိန်းချုပ်ခြင်းနှင့် ထပ်ဆောင်းမြေသြဇာကျွေးခြင်းတို့ကြောင့် အတန်းလိုက် အစေ့ချစိုက်ပျိုးခြင်းနှင့် အကွက်ဖော်အစေ့ချစိုက်ပျိုးခြင်းကိုသုံးရန် အကြံပြုပါသည်။

ရွှံ့မြေ

မြေမှုန်များသေးငယ်ပြီး အချင်းချင်းတင်းကြပ်စွာ စေးကပ်မှုရှိသည်။

မိုးရေတင်ကျန်ရစ်သည်။

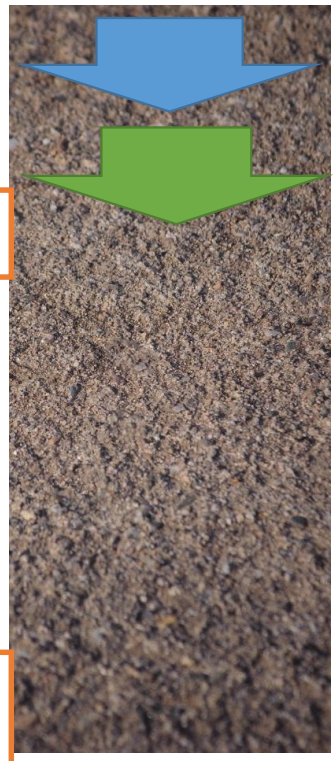
အာဟာရများတင်ကျန်ရစ်သည်။

အောက်ခြေပိုင်းမြေသြဇာကျွေးခြင်းကထိရောက်သည်။

ထွန်ယက်ရန်ခက်ခဲ
မြောင်းဖော်ရန်ခက်ခဲ

ပေါင်းနှုတ်ရန်ခက်ခဲ

အတန်းလိုက်အစေ့ချစိုက်ပျိုးခြင်းနှင့် အကွက်ဖော်အစေ့ချစိုက်ပျိုးခြင်းကိုသုံးရန် အကြံပြုပါသည်။

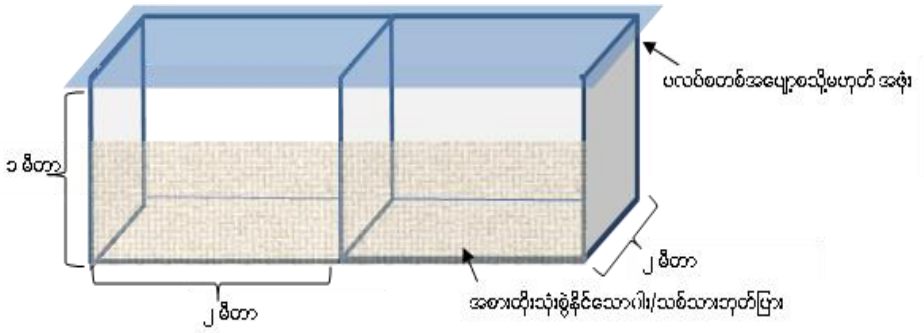


သဘာဝဓါတ်မြေသြဇာ ထည့်ပေးခြင်းသည် မြေအမျိုးအစားနှစ်ရပ်လုံးကို တိုးတက်စေနိုင်သည်။ သဘာဝဓါတ်မြေသြဇာသည် ရေနှင့်အာဟာရဓါတ်များကို ထိန်းထားပေးရုံသာမက ငွင်းတို့ကိုအပင်များက ပိုမိုလွယ်ကူစွာအသုံးပြုနိုင်ရန်လည်း လုပ်ပေးသည်။ မြေတစ်ဇကာလျှင် သဘာဝဓာတ်မြေသြဇာ ၈ တန်သုံးခြင်းက အကောင်းဆုံးဖြစ်ပါသည်။

သဘာဝဓါတ်မြေဩဇာပြုလုပ်ခြင်း

၁။ သဘာဝဓါတ်မြေဩဇာတွင်း ပြုလုပ်ပါ။

အင်္ဂတေကြမ်းခြင်း၊ နံရံသုံးဘက်နှင့် အစားထိုးသုံးစွဲနိုင်သည့် ဂါး/သစ်သား၊ တံခါး



၂။ ပါဝင်ပစ္စည်းများ စုဆောင်းပါ။

ကျွဲချေး၊နွားချေးနှင့် ကောက်ပင်အရိုးများကို စုဆောင်းပါ။

၃။ စုပုံပါ

၁။ ၄င်းတို့ကိုစုပုံပါ။
၂။ အပုံကိုရေဖြန်းပါ။
၃။ အပုံအတွင်း အပူထွက်လာကြောင်းသေချာစေပါ။
၄။ ထိုအပူအေးသွားစေရန် ၁ လစောင့်ပါ။

၄။ အထက်အောက်လှန်ပါ

၁။ အပြင်လွှာကိုအတွင်းတွင်ထားပြီး အတွင်းလွှာကိုအပြင်ပို့ခြင်းဖြင့် ရောနှောပါ။(အထက်အောက်လှန်ခြင်း)
၂။ နောက်ထပ် ၁ လအကြာတွင် နောက်တစ်ကြိမ် အထက်အောက်လှန်ပါ။
၃။ သဘာဝမြေဩဇာသည် အနက်ရောင်ပြောင်းသွားမည်။
၄။ သုံးရန်အသင့်ဖြစ်ပါပြီ။

၅။ အသုံးပြုပါ

၁။ မြေအပေါ်ယံလွှာနှင့် ကောင်းစွာရောနှောပါ။
၂။ တစ်ဧကလျှင် ၈ တန်နှုန်းက အကောင်းဆုံးဖြစ်သည်။
၃။ မည်သည့်ပမာဏမဆို လုံးဝမသုံးခြင်းထက်ကောင်းသည်။

[Soil Manual]

Soil management for sesame production in Magway Region

Background

Magway region is the most important production area of black sesame in Myanmar. Soil of Magway region can be roughly classified into clay soil in lowland and sandy soil in plateau. What is important in soil management is to reduce the problem caused due to the soil characteristics and to make good use of their characteristics.

Soil is a mixture of in-organic materials and organic matters (living organisms and decomposed remains of living organisms). In-organic materials can be classified into three types by their particle size; clay, silt and sand. Particles of clay is the smallest and particles of sand is the largest. Clay soil holds water tightly and stick together tightly. Sandy soil does not hold much water and does not stick together. Organic materials help to hold water and nutrients. They help clay soil not to stick too tightly together and help sandy soil to stick together softly. Thus mixing organic matters such as compost is important in soil management. Also, it is important to understand the characteristics of soil for better soil management. Soil management is to make good use of the soil by using their characteristics to advantage and prevent input and effort to be wasted.

- **Characteristics of Clay Soil and Practical Advice**

  This type of soil is sticky when wet. They stick together and get hard when the soil is dry. Water cannot pass easily in this soil and vertical movement of water is limited. Thus suitable for paddy rice cultivation but difficult for sesame production since ridge making and weeding are difficult. These cause dense planting and make spraying and supplemental fertilization difficult. Water cannot move freely in this type of soil. This characteristic is the disadvantage of this type of soil, so that adding organic matters such as compost is important. However, this characteristic can be an advantage because limitation on movement of water means limitation for nutrients flowing away. For this type of soil, **basal fertilization** is recommendable, and **the fertilizers should be mixed with plough layer**. Best way of seedling is stripe seeding or hill seeding.

- **Characteristic of Sandy Soil and Practical Advice**

  This type of soil is easy to manage when making ridge and removing weed. However, vertical movement of water is easy for this soil and rainwater drains below the top soil quickly. If top layer is not too deep such as more than 1 meter and clay or silty soil layer is underneath the sandy top layer, water and nutrients might

stay even when rains. If sandy top layer is too deep to hold water, it is likely that important nutrients such as nitrogen and potassium get leached down deep below the surface and not able for plants to use. In that case, fertilization at the beginning might result in leaching of nutrients by rainwater and likely to be waste. The depth of top soil layer varies even within the same field, so that the effect of fertilizers varies from plot to plot. Therefore, it is more efficient to invest on the **supplemental fertilization by top dressing** than on basal fertilization for sandy soil fields. Broadcasting and ridging and weeding by animal traction as already practice is fine for this soil type.

- **Effective use of gypsum ($CaSO_4 \cdot 2H_2O$) and micronutrients**

  Application of gypsum for sesame cultivation is said to improve the quality of sesame, to correct soil pH and to prevent empty shells of ground nuts growing after sesame. However, experimental study must be done in order to confirm the effect to the sesame quality. What can be said is that high pH may cause deficiency in micronutrients such as iron and zinc. This is why some farmers prefer to spray to the leaf surface as top dressing.

- **Effective use of compost**

  For clay soil, compost will make them less sticky and soil will be easier to plough. Use of compost will improve the nutrients and water holding power of the soil for sandy soil. Thus for both clay and sandy soil, you can expect the physical improvement. On top of these physical improvements of soil, compost will provide nutrients. In order to maintain the productivity, 8 tons of fertilization per acre is desirable.

Compost Making

Background

Farmers in Magway region often farm with livestock. Materials necessary for compost are obtainable from cow dungs, chicken droppings, weed and crop residue from sesame, rice, and legumes such as ground nuts. Some farmers are already making compost but I would like to make remarks in order to make it more effective.

1. Importance of Composting

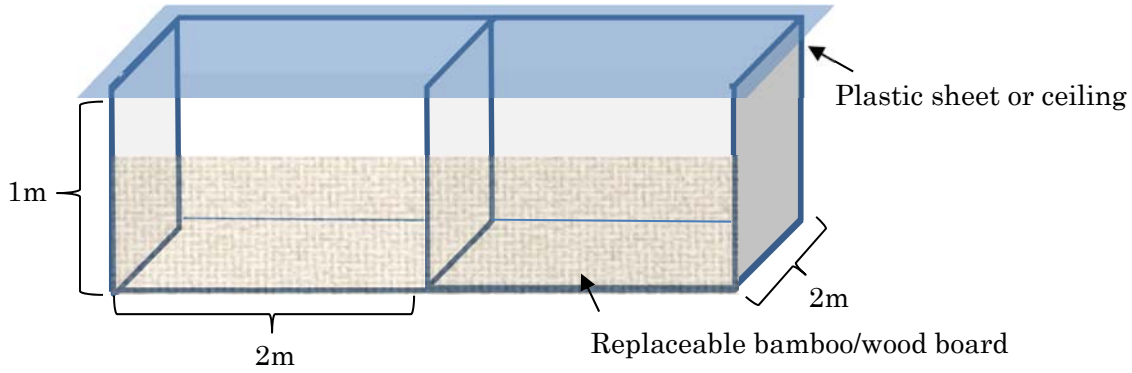
Crop residues usually contains limited amount of nitrogen. If you mix the crop residues directly inside the soil when ploughing, nitrogen will be used in order to decompose the crop residue and might cause nitrogen deficiency for the crop you are going to grow. Also, decomposition in the soil sometimes cause outbreak of insects and soil disease which result in hindering germination and initial growth. Rice straws are useful for livestock feed. Some farmers burn sesame straws at the field. Livestock dungs and droppings are sometimes not collected properly and create unhygienic environment. However, if all those organic matters were properly collected and stored under the good condition for microorganisms, they will be high quality compost. Decomposition by microorganisms generates heat and it will prevent odor, insects and disease. Fertilization of quality compost will improve the physical and chemical condition of the soil. Soil will be able to keep and provide the nutrients and water to the crops. Clay soil will be less sticky and become easier to plough and sand soil will be more retentive of nutrients and water.

2. Magway's locally available organic matters

Combine materials with relatively high nitrogen contents and relatively low nitrogen contents when compiling. Livestock dungs and droppings and legume straws are high in nitrogen. Rice straws and sesame straws are low in nitrogen.

3. Compost pit

Makes space for compost heap. Flat cement floor with brick walls of 1 meter height on three sides with ceiling is ideal. Area is 2 meter depth and 4 meter width with a partition at the middle. If possible, removable bamboo or wood board for forth side will be helpful. You can substitute plastic sheet for ceiling.



4. Compost making

To mix easily, chop straws in 20 cm length. Pile all the materials (livestock dungs, chopped crop residues, weed, and leftover food if any) up to 1m height. Pour water over the pile to wet. Cover the pile with plastic sheet. After a few days, inside of the pile will reach 50 to 60 degree Celsius (if you put your hand inside the pile, you can feel the heat). After about a month, the temperature will drop and total volume of the pile will decrease. Then you turn over the compost and put outside layer inside. The inside of the pile will get hot again for decomposition. After a month, you turn over the compost again for even decomposition. Heat produced for decomposition of organic wastes will destroy most of the weed seeds, fungal disease, pests and parasites.

5. Completion

When pile's color turned black, volume reduced to half and unpleasant smell disappeared, the compost is ready to be used.

6. Fertilization

8 tons of compost per acre is ideal. (even if achieving 8 tons/acre is difficult, any amount is better than nothing)

မကွေးတိုင်းဒေသကြီးရှိ နှမ်းထုတ်လုပ်ရေးအတွက် မြေသားစီမံခန့်ခွဲမှု

နောက်ကြောင်း

မကွေးတိုင်းဒေသကြီးသည် မြန်မာနိုင်ငံတွင် နှမ်းနက်ထုတ်လုပ်မှုအတွက် အရေးပါဆုံးသောမြေနေရာဖြစ်သည်။ မကွေးတိုင်းဒေသကြီး၏ မြေသားကို အကြမ်းဖျင်းအားဖြင့် မြေနိမ့်ပိုင်းတွင် ရွှံ့မြေနှင့် ကုန်းမြင့်ပိုင်းတွင် သဲမြေဟူ၍ အမျိုးအစားခွဲခြားနိုင်ပါသည်။ မြေသားစီမံခန့်ခွဲမှုတွင် အရေးပါသည်မှာ ထိုမြေသား၏ဂုဏ်သတ္တိများကြောင့် ဖြစ်ပေါ်လာသောပြဿနာကို လျော့ချရန်နှင့် ၄င်းတို့၏ဂုဏ်သတ္တိများကို ကောင်းသည့်ဘက်တွင်အသုံးချနိုင်ရန်ဖြစ်သည်။

မြေသားဆိုသည်မှာ အော်ဂဲနစ်မဟုတ်သော အရာဝတ္ထုများနှင့် အော်ဂဲနစ်မတ္တာများ (သက်ရှိအော်ဂဲနစ်ဇင်များနှင့် သက်ရှိအော်ဂဲနစ်ဇင်တို့၏ ပုပ်ပျက်သွားသော အကြွင်းအကျန်များ) ၏အရောအနှောတစ်ရပ်ဖြစ်သည်။ အော်ဂဲနစ်မဟုတ်သော အရာဝတ္ထုများတို့ကို ၄င်းတို့၏အမှုန်အရွယ်အစားအလိုက် ရွှံ့၊ နုန်းနှင့် သဲ ဟူ၍ သုံးမျိုးခွဲခြားနိုင်သည်။ ရွှံ့၏အမှုန်များသည် အသေးငယ်ဆုံးဖြစ်ပြီး သဲ၏အမှုန်များသည် အကြီးဆုံးဖြစ်သည်။ ရွှံ့မြေသည် ရေကိုတင်းကြပ်စွာထိန်းထားနိုင်ပြီး အချင်းချင်းတင်းကြပ်သောစေးကပ်မှုရှိသည်။ သဲမြေသည် ရေကိုများများစားစား ထိန်းမထားနိုင်သည့်အပြင် အချင်းချင်းစေးကပ်မှုမရှိပါ။ အော်ဂဲနစ်အရာဝတ္ထုများက ရေနှင့်အာစာရခါတ်များကို ထိန်းထားနိုင်ရန် အကူအညီပေးသည်။ ၄င်းတို့သည် ရွှံ့မြေကို အချင်းချင်းစေးကပ်လွန်းခြင်းမရှိစေရန် ကူညီပေးသည့်အပြင် သဲမြေကိုအသင့်အတင့် စေးကပ်မှုရှိစေရန် အကူအညီပေးသည်။ ထိုကြောင့် သဘာဝမြေဩဇာကဲ့သို့သော အော်ဂဲနစ်မတ္တာများဖြင့် မြေသားကိုရောနှောပေးခြင်းသည် မြေသားစီမံခန့်ခွဲမှုတွင် အရေးပါသည်။ ထို့အပြင် ပိုမိုကောင်းမွန်သော မြေသားစီမံခန့်ခွဲမှုအတွက် မြေသား၏ဂုဏ်သတ္တိများကို နားလည်ထားရန်လည်း အရေးကြီးပါသည်။ မြေသားစီမံခန့်ခွဲခြင်းဆိုသည်မှာ မြေသားဂုဏ်သတ္တိများကို အသုံးပြုခြင်းအားဖြင့် ပံ့ပိုးထည့်ဝင်မှုနှင့် အားစိုက်ထုတ်မှုကို အကျိုးဖြစ်ထွန်းစေပြီး လေလွင့်မှုကို တားဆီးပေးသဖြင့် ထိုမြေသားကို ကောင်းစွာအသုံးချနိုင်ခြင်းဖြစ်သည်။

- **ရွှံ့မြေ၏ ဂုဏ်သတ္တိများနှင့် လက်တွေ့ကျသောအကြံပြုချက်**

  ဤမြေအမျိုးအစားသည် စိုစွတ်သောအချိန်တွင် စေးကပ်မှုရှိသည်။ ၄င်းတို့သည်အချင်းချင်းစေးကပ်နေပြီး ခြောက်သွေ့သွားချိန်တွင် မာကြောသွားသည်။ ထိုမြေသားအတွင်းသို့ ရေသည်အလွယ်တကူဖြတ်သန်းသွားနိုင်ခြင်း မရှိဘဲ ရေ၏ဒေါင်လိုက်ရွှေ့လျားနိုင်မှုကို ဟန့်တားထားသည်။ ထိုအတွက်ကြောင့် စပါးစိုက်ပျိုးမှုအတွက် သင့်လျော်သော်လည်း မြောင်းဖော်ခြင်းနှင့် ပေါင်းနှတ်ခြင်းတို့ပြုလုပ်ရန်ခက်ခဲသဖြင့် နှမ်းစိုက်ပျိုးရန်အတွက် ခက်ခဲပါသည်။ ၄င်းတို့က သိပ်သည်းသောစိုက်ပျိုးမှုကို ဖြစ်ပေါ်စေပြီး ရေဖြန်းခြင်းနှင့် ထပ်ဆောင်းဓါတ်မြေဩဇာကျွေးခြင်းတို့ကို ခက်ခဲစေသည်။ ရေသည် ထိုမြေအမျိုးအစားတွင် လွတ်လပ်စွာရွှေ့လျားနိုင်ခြင်းမရှိပါ။ ဤဂုဏ်သတ္တိသည် ဤမြေအမျိုးအစားအတွက် အားနည်းချက်ဖြစ်သောကြောင့် သဘာဝဓါတ်မြေဩဇာကဲ့သို့သော အော်ဂဲနစ်မတ္တာများဖြည့်ထည့်ခြင်းသည် အရေးကြီးသည်။သို့သော် ရေ၏ရွှေ့လျားနိုင်မှုကို ဟန့်တားခြင်းက အာဟာရဓါတ်များစီးဆင်းခြင်းကိုလည်း ဟန့်တားရာရောက်သဖြင့် ထိုဂုဏ်သတ္တိကပင်လျှင် အားသာချက်တစ်ရပ်ဖြစ်နိုင်ပါသည်။ ထိုမြေအမျိုးအစားအတွက် **အောက်ခြေပိုင်းဓါတ်မြေဩဇာကျွေးခြင်း**ကို အကြံပြုနိုင်ပြီး **ထိုဓါတ်မြေဩဇာများသည် ထွန်ယက်သည့်အလွှာတွင် ရောနှောထားရပါမည်။** အညောက်ဖောက်ခြင်းအတွက် အကောင်းဆုံးနည်းလမ်းမှာ အတန်းလိုက်ဖြစ်စေ အကွက်ဖော်ပြီးဖြစ်စေ အစေ့ချစိုက်ပျိုးခြင်းဖြစ်သည်။

- **သဲမြေ၏ ဂုဏ်သတ္တိများနှင့် လက်တွေ့ကျသောအကြံပြုချက်**

  ဤမြေအမျိုးအစားသည် ဇောင်းဖော်ရာတွင်လည်းကောင်း၊ ပေါင်းပင်များဖယ်ရှားရာတွင်လည်းကောင်း၊ စီမံခန့်ခွဲရန်လွယ်ကူသည်။ သို့သော် ထိုမြေတွင် ရေ၏ဒေါင်လိုက်ရွှေ့လျားမှုမှာ လွယ်ကူပြီး မိုးရေသည်မြေ၏အပေါ်ယံအလွှာအောက်သို့ လျှင်မြန်စွာစီးဆင်းသွားသည်။ အကယ်၍ အပေါ်ယံအလွှာသည် ၁ မီတာထက်ပိုသော လွန်စွာနက်ရှိုင်းခြင်း မရှိသည့်အပြင် အပေါ်ယံသဲမြေအလွှာအောက်၌ ရွှံ့ သို့မဟုတ် နုန်းဆန်သောမြေလွှာရှိပါက ရေနှင့်အာဟာရဓါတ်များသည် မိုးရွာသွန်း နေချိန်မှာပင် ဆက်လက်တည်ရှိနေနိုင်ပါသည်။ အကယ်၍ အပေါ်ယံသဲမြေအလွှာသည် ရေကိုထိန်းထားရန် နက်ရှိုင်းလွန်းပါက နိုက်ထရိုဂျင်နှင့် ပိုတက်ဆီယမ်တို့ကဲ့သို့ အရေးပါသည့်အာဟာရဓါတ်များသည် မျက်နှာပြင်မှနက်ရှိုင်းသောအောက်ခြေသို့တိုင် ယိုစိမ့်သွားသဖြင့် အပင်များကသုံးစွဲနိုင်ခြင်းမရှိတော့သည့်သဘော ဖြစ်တတ်ပါသည်။ ထိုသို့ဖြစ်ပါက အပေါ်ယံပိုင်းတွင် ဓါတ်မြေဩဇာကျွေးခြင်းသည် အာဟာရဓါတ်များကို မိုးရေဖြင့်မျောပါသွားစေခြင်း ဖြစ်စေနိုင်သဖြင့်

အလဟာသဆုံးရှုံးသည့် သဘောဖြစ်နိုင်ပါသည်။ အပေါ်ဆုံးမြေသားအလွှာ၏ နက်ရှိုင်းမှုမှာ ကွဲပြားခြားနားတတ်သဖြင့် ဓါတ်မြေဩဇာ၏သက်ရောက်မှုမှာလည်း မြေကွက်အလိုက် ခြားနားနိုင်သည်။ ထိုကြောင့် သဲမြေအမျိုးအစားစိုက်ကွက်များအတွက် **အပေါ်မြေလွှာတွင် ထပ်ဆောင်းဓါတ်မြေဩဇာကျွေးခြင်းထက်** အောက်ခြေပိုင်းတွင် ဓါတ်မြေဩဇာဖြည့်ထည့်ခြင်းတွင် အကုန်အကျခံပါက ပိုပိုအကျိုးဖြစ်ထွန်းပါမည်။ ယခင်ကျင့်သုံးနှင့်ပြီးဖြစ်သော တိရစ္ဆာန်အားကိုအသုံးပြုပြီး မျိုးစေ့ကြဲ ခြင်း၊ မြောင်းဖော်ခြင်းနှင့် ပေါင်းသင်ခြင်းတို့သည် ဤမြေအမျိုးအစားအတွက် အဆင်ပြေပါသည်။

- **ဂျစ်ပဆမ် (ကယ်လဆီယမ်ဆာလဖိတ်ဒီဟိုက်ဒြိတ် $CaSO_4 \cdot 2H_2O$) နှင့် မိုက်ခရို အာဟာရဓါတ်များကို ထိရောက်စွာအသုံးပြုခြင်း**

နှမ်းစိုက်ပျိုးရေးအတွက် ဂျစ်ပဆမ်အသုံးပြုခြင်းသည် နှမ်းအရည်အသွေးကို တိုးတက်စေရန်၊ မြေသား၏ pH ကိုပြုပြင်ရန်နှင့် နှမ်းစိုက်ခင်းအပြီး မြေပဲစိုက်ခင်းတွင် အဆံချောင်ဖြစ်ခြင်းကို ကာကွယ်ရန်ဟုဆိုကြသည်။ သို့ရာတွင် နှမ်း၏အရည်အသွေးတွင်သက်ရောက်မှုရှိကြောင်း အတည်ပြုနိုင်ရန်အတွက် လက်တွေ့စမ်းသပ်လေ့လာမှု ပြုလုပ်ရပါမည်။သေချာသည်မှာ pH မြင့်မားခြင်းသည် အိုင်းယွန်းနှင့်ဇင့်ကဲ့သို့သော မိုက်ခရိုအာဟာရဓါတ်များကို လျော့ကျမှုဖြစ်စေနိုင်သည်။ ထိုအကြောင်းကြောင့် အချို့သောလယ်သမားများက အရွက်ဖျန်းဆေးကိုသုံးရန် ပိုမိုအားသန်ကြခြင်းဖြစ်သည်။

- **သဘာဝဓါတ်မြေဩဇာ ထိရောက်စွာအသုံးချခြင်း**

ရှိုမြေအတွက် သဘာဝဓါတ်မြေဩဇာက စေးကပ်မှုကိုလျော့နည်းစေပြီး ထွန်ယက်ရလွယ်ကူစေပါလိမ့်မည်။ သဘာဝဓါတ်မြေဩဇာအသုံးပြုခြင်းက အာဟာရဓါတ်များနှင့် သဲမြေအတွက် ရေကိုထိန်းထားနိုင်စွမ်းကို မြှင့်တင်ပေးနိုင်သည်။ ထို့ကြောင့် ရှိုမြေနှင့်သဲမြေနှစ်မျိုးစလုံးအတွက် ရုပ်ပိုင်းဆိုင်ရာတိုးတက်မှုကို မျှော်မှန်းနိုင်သည်။ မြေသား၏ရုပ်ပိုင်းဆိုင်ရာတိုးတက်မှုများအပြင် သဘာဝဓါတ်မြေဩဇာက အာဟာရဓါတ်များကို ပံ့ပိုးပေးနိုင်သည်။ သီးနှံအထွက်နှုန်းကို ထိန်းထားနိုင်ရန်အတွက် မြေတစ်ဇကလျှင် မြေဩဇာ ၈ တန်ကို ထည့်ပေးရန်လိုအပ်သည်။

သဘာဝဓါတ်မြေဩဇာပြုလုပ်ခြင်း

နောက်ကြောင်း

မကွေးတိုင်းဒေသကြီးရှိ တောင်သူများတို့သည် တိရိစ္ဆာန်များသုံးပြီး လယ်ယာစိုက်ပျိုးလေ့ရှိကြသည်။ သဘာဝဓါတ်မြေဩဇာပြုလုပ်ရာတွင် လိုအပ်သော အခြေခံပါဝင်ပစ္စည်းများကို နွားချေး၊ ကြက်ချေးနှင့် နှမ်း၊ စပါး၊ မြေပဲကဲ့သို့သော ပဲအမျိုးမျိုးတို့၏ကောက်ရိုးများမှရရှိနိုင်သည်။ အချို့သောလယ်သမားများသည် သဘာဝဓါတ်မြေဩဇာကို ပြုလုပ်နေနှင့်ကြပြီဖြစ်သော်လည်း ပိုမိုထိရောက်မှုရှိရန် လုပ်ဆောင်ခြင်းအတွက် အကြံပြုချက်များပေးလိုပါသည်။

၁။ သဘာဝဓါတ်မြေဩဇာအသုံးပြုခြင်း၏ အရေးပါမှု

ကောက်ပင်အကြွင်းအကျန်များတွင် နိုတ်ထရိုဂျင်ပမာဏအနည်းငယ်ပါရှိလေ့ရှိတတ်သည်။ ထွန်ယက်ချိန်တွင် ကောက်ပင်အကြွင်းအကျန်များကို တိုက်ရိုက်ထည့်သွင်းရောနှောလိုက်ပါက ထိုကောက်ပင်အကြွင်းအကျန်ကို ပုပ်ပျက်စေရန်အတွက် နိုတ်ထရိုဂျင်ကို အသုံးပြုရလိမ့်မည်ဖြစ်ပြီး စိုက်ပျိုးမည့်သီးနှံအတွက် နိုတ်ထရိုဂျင်လျော့ပါးမှုကိုဖြစ်ပေါ်စေနိုင်သည်။ မြေသားအတွင်းပုပ်ပျက်စေခြင်းသည် အင်းဆက်ပိုးမွှားများနှင့် မြေသားအတွင်းရောဂါဖြစ်ခြင်းကို ရံဖန်ရံခါပျံ့နှံ့စေနိုင်သဖြင့် စေ့အညောက်ပေါက်ခြင်းနှင့် ကနဦးကြီးထွားမှုကို အဟန့်အတားဖြစ်ပေါ်စေပါသည်။ စပါးပင်၏ကောက်ရိုးများကို ကျွဲနွားအစာအဖြစ်အသုံးပြုနိုင်သည်။ အချို့သောတောင်သူများတို့သည် နှမ်းပင်၏ကောက်ရိုးများကို စိုက်ခင်းနေရာတွင် မီးရှို့လေ့ရှိကြသည်။ ကျွဲချေး၊ နွားချေးများနှင့် ကြက်ဘဲချေးများကို ရံဖန်ရံခါ မှန်ကန်စွာကောက်သိမ်းခြင်းမရှိသဖြင့် ကျန်းမာရေးနှင့်မညီညွတ်သည့် ပန်းကျင်ကိုဖန်တီးရာရောက်သည်။ သို့ရာတွင် အဆိုပါအော်ဂဲနစ်မတ္တာများကို မှန်မှန်ကန်ကန်စုသိမ်းပြီး မိုက်ခရိုအော်ဂဲနစ်ဇင်များအတွက် အနေအထားကောင်းတစ်ရပ်အောက်တွင် သိုလှောင်ထားပါက ၎င်းတို့သည် အရည်အသွေးမြင့်မားသော သဘာဝဓါတ်မြေဩဇာဖြစ်လာပေမည်။ မိုက်ခရိုအော်ဂဲနစ်ဇင်များအားဖြင့် ပုပ်ပျက်စေခြင်းသည် အပူကိုထုတ်လွှတ်ပေးပြီး ၎င်းက အနံ့ဆိုးထွက်ခြင်း၊ အင်းဆက်ပိုးမွှားများနှင့်ရောဂါဘယတို့ကို ကာကွယ်ပေးပါမည်။

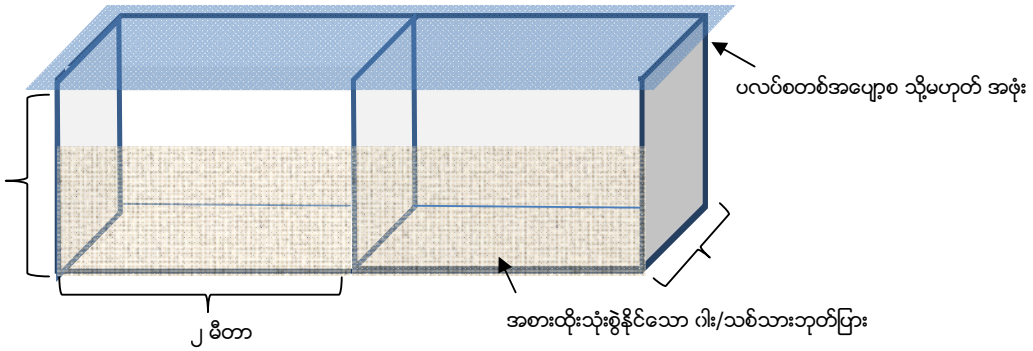
အရည်အသွေးမြင့်မားသော သဘာဝဓါတ်မြေဩဇာဖြင့် မြေဆီမြေဩဇာကြွယ်ဝစေခြင်းသည် ထိုမြေသား၏ ရုပ်ပိုင်းနှင့် ဓါတ်ဂတ္ထုဆိုင်ရာအခြေအနေကို မြှင့်တင်ပေးပါမည်။ မြေသားက အာဟာရဓါတ်များနှင့်ရေကို ထိန်းသိမ်းထားပြီး ကောက်ပဲသီးနှံများထံ ပံ့ပိုးပေးနိုင်ပါသည်။ ရှုံ့မြေသည်လည်းစေးကပ်မှုလျော့နည်းသွားပြီး ထွန်ယက်ရလွယ်ကူလာသကဲ့သို့ သဲမြေသည် အာဟာရဓါတ်နှင့်ရေကို ပိုမိုထိန်းသိမ်းထားနိုင်လာပါမည်။

၂။ မကွေး၏ နယ်မြေအတွင်းရနိုင်သည့် အော်ဂဲနစ်မတ္တာများ

နိုတ်ထရိုဂျင်ပါဝင်မှု အထိုက်အလျောက်မြင့်မားသော အရာဝတ္ထုများနှင့် နိုတ်ထရိုဂျင်ပါဝင်မှု အထိုက်အလျောက်နည်းပါးသော အရာဝတ္ထုများကိုစုပုံချိန်တွင် ရောနှောရပါမည်။ ကျွဲချေး၊ နွားချေးနှင့်ကြက်ချေးများနှင့် ပဲပင်အရိုးများသည် နိုတ်ထရိုဂျင်ပါဝင်မှုမြင့်မားသည်။ စပါးပင်၏ကောက်ရိုးနှင့် နှမ်းပင်အရိုးများသည် နိုတ်ထရိုဂျင်ပါဝင်မှုနည်းပါးသည်။

၃။ သဘာဝဓါတ်မြေဩဇာတွင်း

သဘာဝဓါတ်မြေဩဇာပုံအတွက် နေရာပြုလုပ်ပါ။ ညီညာသောအင်္ဂတေကြမ်းခင်းနှင့် အနားသုံးဘက်တွင် ၁ မီတာမြင့်သော အုတ်ရိုးအပေါ်တွင် အဖုံးပါရှိခြင်းသည် အကောင်းဆုံးအနေအထားဖြစ်သည်။ ဇရိယာမှာ ၂ မီတာအနက်၊ ၄ မီတာအကျယ်ကို အလယ်တည့်တည့်တွင် ကန့်ထားရပါမည်။ ဖြစ်နိုင်သည်ဆိုပါက ပြန်လည်ဖယ်ရှားနိုင်သော ဂါး သို့မဟုတ် သစ်သားဘုတ်ပြားကို နှစ်ကန့်လုံးတွင်ထည့်ထားပါက အထောက်အကူဖြစ်ပါလိမ့်မည်။ အဖုံးကို ပလပ်စတစ်အပျော့စဖြင့် အစားထိုးနိုင်သည်။



၄။ သဘာဝဓါတ်မြေဩဇာပြုလုပ်ခြင်း

လွယ်ကူစွာရောနှောနိုင်ရန် ကောက်ရိုးများကို ၂၀ စင်တီမီတာအရှည်ဖြတ်ပါ။ ပါဝင်သောပစ္စည်းများအားလုံး (ကျွဲချေး၊ နွားချေး၊ ဖြတ်ထားသည့်ကောက်ပင်အကြွင်းအကျန်များ၊ ပေါင်းပင်နှင့် အစားအစာအကြွင်းအကျန်များ ရှိသည်ဆိုပါက) ကို ၁ မီတာအမြင့်အထိ ပုံလိုက်ပါ။ ထိုအပုံကိုစိုစွတ်သွားစေရန် အပေါ်မှရေလောင်းချပါ။ ထိုအပုံကို ပလပ်စတစ်အပျော့စဖြင့် ဖုံးအုပ်ထားပါ။ ရက်အနည်းငယ်ကြာပြီးနောက်တွင် ထိုအပုံအတွင်းပိုင်းသည် ၅၀ မှ ၆၀ ဒီဂရီဆဲလ်စီးယပ်စ်အထိ ရောက်ရှိလာပါလိမ့်မည် (သင်၏လက်ကို ထိုအပုံအတွင်းထည့်ကြည့်ပါက ထိုအပူချိန်ကို သင်ခံစားနိုင်ပါသည်။)။ တစ်လခန့်ကြာပြီးနောက်တွင် ထိုအပူချိန်သည် လျော့ကျသွားပြီး ထိုအပုံ၏အရွယ်အစားပမာဏလည်း လျော့သွားပါလိမ့်မည်။ ထို့နောက် ထိုသဘာဝဓါတ်မြေဩဇာအပုံကို အထက်အောက်လှန်ပြီး အပြင်ပိုင်းကို အတွင်းတွင်ထားပါ။ ထိုအပုံ၏အတွင်းပိုင်းသည် ပုပ်ပျက်ခြင်းအတွက် ထပ်မံပူလာပါလိမ့်မည်။ နောက်ထပ်တစ်လခန့်ကြာပြီးနောက်တွင် ထိုအပုံကိုပိုမိုဆွေးမြေ့သွားစေရန်အတွက် နောက်တစ်ကြိမ်အထက်အောက်လှန်ပါ။ ပုပ်ပျက်စေရန်အတွက် အော်ဂဲနစ်ပစ္စည်းများမှ ထွက်လာသောအပူသည် ပေါင်းပင်၏အစေ့များ၊ မှိုရောဂါ၊ ပိုးမွှားနှင့် ကပ်ပါးကောင်များကို ဖျက်ဆီးပါလိမ့်မည်။

၅။ ပြီးမြောက်ခြင်း

ထိုအပုံ၏အရောင်သည် အနက်ရောင်ပြောင်းသွားပြီး၊ ပမာဏလည်း ထက်ဝက်ခန့်လျော့ကျသွားကာ မကောင်းသည့်

အနုံ့အသက်များပျောက်သွားချိန်တွင် ထိုသဘာဂဓါတ်မြေဩဇာသည် အသုံးပြုရန်အသင့်ဖြစ်ပါပြီ။

၆။ မြေဩဇာကွေးခြင်း

မြေတစ်ဇကလျှင် သဘာဂမာတ်မြေဩဇာ ၈ တန်သုံးခြင်းက အကောင်းဆုံးဖြစ်ပါသည်။ (တစ်ဇက ၈ တန်သုံးခြင်းက အခက်အခဲဖြစ်သည်ဆိုပါက မည်သည့်ပမာဏမဆို လုံးဂမသုံးခြင်းထက်ပိုကောင်းပါသေးသည်။)

Manual for Pests and Pest Management Method on Sesame Plants in Magway Region

2017

JAICAF

Contents

1. Background and purposes
2. Investigation methods
3. Major sesame pests
4. Major natural enemies
5. Pest management methods (General)
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7. Pest problems

1. Background and purposes

- Technical cooperation project for agricultural productivity and quality improvement of sesame seeds in Myanmar, which was aided by the Ministry of agriculture, forestry and fisheries, Japan, was carried out by JAICAF with the Ministry of agriculture, livestock and irrigation, Myanmar.
- We investigated sesame pests and natural enemies occurrences in Magway Region. This manual is for agricultural technical experts (researchers, extension officers, etc.) based on the result of this investigation. We also present pest management methods and pest problems in this manual.

2. Investigation methods

We used the following methods selected from various methods.

(1) Sweeping method

We swept 20 times with an insect net (36cm in diameter) in each field, and caught various insects.

(2) Direct counting method

We counted and caught insects directly.

(3) Sticky trap method

We set yellow sticky traps in sesame fields, and caught various small insects.

**If you want to attract owlet moths, the pheromone trap is effective*

3. Major sesame pests

Kind	Family name	Main exemplification	Sesame investigation point with pests (%)	Weed investigation point with pests (%)
Aphids (Virus diseases)	Aphididae	*Myzus persicae* (Green peach aphid)	0.0 (Virus 15.0)	0.0
Leafhoppers (Phytoplasma disease)	Cicadellidae	*Orosius albicinetus* (Sesamum jassid)	55.0 (Phytoplasma 52.5)	56.3
Plant bugs	Pentatomidae Pyrrhocoridae Lygaeidae	*Nezara* spp., *Dysdercus* spp., *Aphamus sordidus* (Sesamum seed bug)	42.5	43.8
Scarabs	Scarababidae	*Anomala antiqua* (Sesamum blach beetle)	5.0	0.0
Pyralid moths	Pyralidae	*Antigastra catalaunalis* (Sesamum leaf roller)	5.0	0.0
Sphinx moths	Sphingidae	*Acherontia styx* (Death's head moth)	0.0	6.3
Tiger moths	Arcitiidae	*Spilosoma obliqua* (Common hairy caterpillar)	5.0	0.0
Owlet moths	Noctuidae	*Helicoverpa armigera* (Cotton bollworm)	5.0	6.3

（This table is based on our investigations in 2017 and the booklet of Plant Protection Division, Myanmar in 1999）

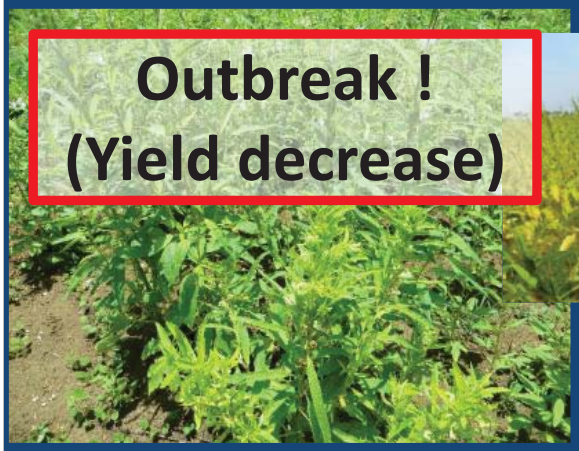
Aphids and Virus

Reference

An adult of *Myzus percicae*, which is probably a vector.

* Virus diseased plants have no seed pod and yield decreases.
* We have little information on the virus and vector.
* Detailed investigation needed.

Leafhoppers and Phytoplasma (MLO)



Sesamun jassid
(adult: vector)

Maximum diseased plants
in a field = 47%

Stink bugs, Pyrrhocorid bugs and Lygaeid bugs

A kind of Pyrrhocorid bugs
(*Dysdercus* spp.: adult)

Sucking mouth

Scarabs

* Scarabs larvae can severely damage sesame roots.

Pyralid moths

Sesamum leaf roller (larvae)

Sphinx moths

A larvae collected in Myanmar (larva)

Reference

A kind of sphinx moths collected in Japan

Tiger moths

Common hairy caterpillar (larva)

(photo By Dr. Kuwahara)

Owlet moths

Several kinds of owlet moth larvae

* Several owlet moths such as cotton bollworm, common cutworms, etc. can severely damage sesame plants under outbreak conditions.

Small insects trapped by yellow sticky traps

Sesamun jassid（adult)

* Leafhoppers were trapped, but aphids which were attracted by yellow were not trapped in June and July, 2017.

4. Major natural enemies

Kind	Family name	Exemplification	Sesame investigation point with natural ememies (%)	Weed investigation point with natural enemies (%)
Green lacewings	Chrysopidae	*Chrysoperla carnera*	2.5	0.0
Ladybird beetles	Coccinellidae	*Harmonia axyridis*	7.5	0.0
Paracitic wasps	Eulophidae, Braconida,etc.	*Diglyphus isaea, Aphidius colemani*	17.5	12.5
Predaceous bugs	Miridae, Geocoridae, Reduvidae, etc.	*Nesidiocoris tenuis, Geocoris various, Agriosphodrus dohrni*	32.5	6.3
Spiders	Thomisidae etc		10.0	12.5

Parasitic wasps

Reference

A kind of Braconidae

* Parasitic wasps such as Eulophidae and Braconidae are very important natural enemies.

Predatory bugs

* In Myanmar we observed predatory bugs such as Miridae, Geocoridae and Reduvidae.
* In Japan we can often observe tobacco leaf bugs (*Nesisiocoris tenuis*) on sesame plants.

5. Pest management methods (General)

Management method	Main technology
Chemical method	Agrochemicals (Pesticides).
Physical method	Catching and killing. Quarantine. Treatment of light, color and heat.
Ecological method / Cultural method	Crop rotation. Mixed cropping. Intercroping. Ploughing. Cleaning. Barrier crops. Enemy plants. Resistant varieties.
Biological method	Natural enemy formulations. Native natural ememies. Pheromon formulations. Genetic control.

We have several management methods!

Chemical method

Main agrochemicals against sesame insect pests in Myanmar

Component name	Trade name	Characteristic
Deltamethrin 2.5% EC	Decis	Synthetic pyrethroid insecticide
Diazinon 40.0% EC	Diazinon	Organophosphorus insecticide
Dimethoate 40.0% EC	Dimathoate	Organophosphorus insecticide
Fenitrothion 50.0% EC	Sumithion	Organophosphorus insecticide
Fenpropathrin 10.0% EC	Danitol	Synthetic pyrethroid compound insecticide
Imidacloprid 70.0% D and 70% WP	Gaucho and DOZER	Neonicotinoid insecticide
Malathion 50.0% EC	Unknown	Organophosphorus insecticide
Phenthoate 50.0% EC	Unknown	Organophosphorus insecticide

（Agrochemicals were quoted from the technical booklet of Plant Protection Division, Myanmar in 1999）

Use proper agrochemicals properly!

- Buy proper agrochemicals from legal channels based on the law!
- Follow the directions of labels !

  Targeted crops and pests !
  Season and frequency of sprays !
  Proper concentrations !

- Don’t sell sesame seeds which were treated with agrochemicals as sesame products !

* These are very important for safety (residual agrochemicals etc.), cost reduction, insecticidal efficacy and chemical injury prevention.

Biological method

(1) Bio-insecticide

A kind of nematode formulations

- Many kinds of natural enemy formulations (wasps, bugs, mites, nematodes, etc.) are on the market.

(2) Native natural enemies

- Native natural enemies are controlling insect pests in fields.
- Native natural enemies can be preserved and propagated by the management of vegetations (crops and weeds) as their habitats in fields.

Physical method

- Basic method for controlling insect pests
- Riding weeds and diseased plants
- Catching and killing insect pests
- Using reflection mulch sheets, yellow plates and net (5mm mesh for bugs)

Ecological (Cultural) method

- Barrier crops such as sorgos, maize and millet protect sesame plants against small insect pests.

- Suitable management of organic matters in soil of fields is important, because organic rich soil attracts the adult of scarabs.

Targeting IPM

- Globally, integrated pest management (IPM) has been recognized. IPM is essential to plant protection all over the world.
- IPM have extended in the horticulture under structure conditions. In the future we should extend in the horticulture under field conditions.
- Various technologies on IPM should be developed based on the agricultural condition in each country and region.
- IPM is evolving from conventional IPM into bio-intensive IPM.

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IPM system in Japan

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

(Extracted from the Ministry of Agriculture, Forestry and Fisheries, in 2005)

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6. Pest management methods (Particular)

Aphids and Virus disease

- We should control aphids, vectors, at the former stage of cultivations, and rid diseased plants.
- We spray agrochemicals in the fields where the outbreak of virus diseases occur every year.
- We should use the agrochemicals which is recommended by DOA and DAR, Myanmar.

Leafhopper (Sesamum jassid) and Phytoplasma disease

- We should control the sesamum jassid, a vector, at the former stage, and rid diseased plants.
- We spray agrochemicals in the fields where the outbreak of phytoplasma disease occur every year.
- We should use the insecticide which is recommended by DOA and DAR, Myanmar.

Plant bugs

- We can disregard the damage of plant bugs under normal occurrence conditions.

Scarabes

- Organic rich soil attract the adult of scarabs.
- We should catch and kill larvae in soil near plants.
- The latent damage, which is caused by larvae in soil, is rather severe.
- We should use the agrochemicals which is recommended by DOA and DAR, if you spray.

Pyralid moths, Sphinx moths and Owlet moths

- We can disregard the damage of these moths under normal occurrence conditions, although we should be on the lookout for the outbreak of these moths.
- We should catch and kill larvae on plants.

Tiger moths

- We can disregard the damage of tiger moths under normal occurrence conditions.
- We should catch and kill larvae on plants.

7. Pest problems

(1) Sesame pests in Myanmar

- The sesame pest problem is serious in Myanmar. We should understand that the pest problem causes the agrochemical residue.
- The ecological information on major sesame pests is essential for pest management.
- We should investigate the seasonal change of major sesame pests every year, because pest occurrences differ in each year.

(2) At the former stage: Diseases such as virus and phytoplasma transmitted by insect pests

- The outbreak of diseases transmitted by vector insects is occurring in many fields of Myanmar.

- Sesame plants are infected with these disease at the former stage. So we should control vector insects such as aphids and leafhoppers (jassid) at the former stage.

- Permeability agrochemicals are efficacious. Seed treatments with agrochemicals before sowing are also efficacious as a chemical method.

- We should rid diseased plants from fields for protecting the spread of infections as a physical method.

- Barrier crops, such as sorgo, maize and millet plants, protect the come flying of small insect pests as an ecological and cultural method.

(3) At the latter stage: Lepidopteran insect pests with a chewing mouth

- Several kinds of lepidopteran insect pests occur at the latter stage.

- Synthetic pyrethroid and organophosphorus agrochemicals are efficacious as a chemical method, but we should refrain from the spraying of agrochemicals at the latter stage.

- Capture and killing are effective as a physical method. The using of bio-insecticides are desired in the near future.

- Scarab larvae severely eat sesame roots in soil. Organophosphorus agrochemicals (granule type) are efficacious, but we should refrain from the spraying of agrochemicals at the latter stage. The bio-insecticide like entomopathogenic nematodes is on the market.
- The soil with rich organic matters promote the egg-laying of scarab adults.
- At the latter stage bugs and *Rhizoctonia* diseases occur, and moreover, the disease symptoms caused by phytoplasma and virus are actualized.

(4) At the drying stage: Deterioration of sesame, various pests such as bugs, and agrochemical residue

- Drying in fields should be avoided, because we cannot spray agrochemicals to occurred insect pests at the drying stage.
- Moreover, the deterioration of sesame qualities causes at the drying stage in fields.
- We should reconsider the field drying, and aim to construct new drying systems.

Acknowledgement

Ministry of agriculture, livestock and irrigation, Myanmar

Department of agriculture (DOA), Head office
DOA Regional office, Magway
Department of agricultural research (DAR), Head office
DAR Magway oil seed crop research center

Sesame farmers and agrochemical stores

* This manual was drawn up by JAICAF based on the result of the project, which was funded by the Ministry of agriculture, forestry and fisheries, Japan.

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မာတိကာ

၁။ နောက်ကြောင်းနှင့် ရည်ရွယ်ချက်များ

၂။ စစ်ဆေးဖော်ထုတ်မှုနည်းလမ်းများ

၃။ နှမ်းပင်တွင်အဓိကကျရောက်သည့် ပိုးမွှားများ

၄။ အဓိက သဘာဝရန်သူများ

၅။ ပိုးမွှားနှိမ်နင်းမှုနည်းလမ်းများ (အထွေထွေ)

၆။ ပိုးမွှားနှိမ်နင်းမှုနည်းလမ်းများ (အတိအကျ)

၇။ ပိုးမွှားပြဿနာများ

၁။ နောက်ကြောင်းနှင့်ရည်ရွယ်ချက်များ

- ဂျပန်နိုင်ငံစိုက်ပျိုးရေး၊ သစ်တောနှင့် ငါးဖမ်းလုပ်ငန်း ပန်ကြီဌာနက ပံ့ပိုးကူညီပေးသော မြန်မာနိုင်ငံရှိ နှမ်းစိုက်ပျိုးထုတ်လုပ်ရေးနှင့် နှမ်းစေ့အရည်အသွေးမြှင့်တင်ရေးအတွက် JAIFCA နှင့် မြန်မာနိုင်ငံ လယ်ယာစိုက်ပျိုးရေး၊ ဓမ္မမြို့ရေးနှင့် ဆည်မြောင်းပန်ကြီဌာနတို့ လုပ်ဆောင်သည့် နည်းပညာပူးပေါင်းဆောင်ရွက်ရေး စီမံကိန်းဖြစ်ပါသည်။

- ကျွန်ုပ်တို့သည် မကွေးတိုင်းဒေသကြီးတွင် နှမ်းပင်ဖျက်ပိုးမွှားများနှင့် သဘာဝရန်သူများကို စစ်ဆေးဖော်ထုတ်ခဲ့သည်။ ဤလမ်းညွှန်သည် ထိုစစ်ဆေးတွေ့ရှိချက်ရလဒ်အပေါ် အခြေခံထားပြီး စိုက်ပျိုးရေးနည်းပညာ ကျွမ်းကျင်သူများ (သုတေသီများ၊ ရှုးခွဲအရာရှိများ စသည်) အတွက် ဖြစ်ပါသည်။ ဤလမ်းညွှန်တွင် ပိုးမွှားနှိမ်နင်းရေးနည်းလမ်းများနှင့် ပိုးမွှား ပြဿနာများအကြောင်းကိုလည်း တင်ပြထားပါသည်။

၂။ စစ်ဆေးဖော်ထုတ်မှုနည်းလမ်းများ

ကျွန်ုပ်တို့သည် နည်းလမ်းများစွာတို့မရွေးချယ်ထားသည့် အောက်ပါနည်းလမ်းများကို အသုံးပြုပါသည်။

(၁) ဗျှဲ့ယမ်းသည့် နည်းလမ်း

(အချင်း ၃၆ စင်တီမီတာရှိသော) ပိုးကောင်ဖမ်း ပိုက်ကွန်ဖြင့် စိုက်ခင်း တစ်ခုစီတွင် အကြိမ် ၂၀ ဗျှဲ့ယမ်းပြီး ပိုးမွှားအမျိုးမျိုးတို့ကို ဖမ်းပါသည်။

(၂) တိုက်ရိုက်ရေတွက်သည့်နည်းလမ်း

ပိုးမွှားများကို တိုက်ရိုက် ရေတွက်ပြီး ဖမ်းပါသည်။

(၃) ကော်စေးထောင်ချောက်နည်းလမ်း

အပါရောင်ကော်စေးထောင်ချောက်များကို နှမ်းခင်းများတွင်ထားရှိပြီး ပိုးမွှားအကောင်ငယ် အမျိုးပေါင်းများစွာကို ဖမ်းပါသည်။

ဖီးကွက်စာပိုးဖမ်းများကို ဆွဲဆောင်လိုပါက pheromone ထောင်ချောက်က ထိရောက်သည်။

၃။ နှမ်းပင်တွင် အဓိကကျရောက်သည့်ပိုးမွှားများ

ပိပိုးမ်ား Aphids (ဗိုင်းရပ္စ္ေရာဂါမ်ား)	Aphididae	Myzus persicae (မက်ြန္ဆီးစိမ္းပိပိုး)	0.0 (Virus 15.0)	0.0
ွံေကာင်မ်ား Leafhoppers (Phytoplasma disease)	Cicadellidae	Orosius albicinctus (ွံမ္းပင်ကိုး)	55.0 (Phytoplasma 52.5)	56.3
ပင်ေဖာက်ိုးမ်ား	Pentatomidae Pyrrhocoridae Lygaeidae	Nezara spp., Dysdercus spp., Aphamussordidus (ွံမ္းေစ့ဖ်ိုး)	42.5	43.8
ပိုးေတာင်ွာမ်ား	Scarababidae	Anomala antiqua (ွံမ္းပင်ိုးေတာင်ွာအနက္)	5.0	0.0
ပိုဋ္ဌာလစ္ခ ဖလံမ်ား	Pyralidae	Antigastra catalaunalis (ွံမ္းရြက်ိုး)	5.0	0.0
စဖင်္စ္ ဖလံမ်ား	Sphingidae	Acherontia styx (ေသမင်းေခါင်း ဖလံ)	0.0	6.3
ရြက်ံုစားဖလံမ်ား	Arcitiidae	Spilosoma obliqua (ခူယားေကာင်)	5.0	0.0
ီးကြက်ံုဖလံမ်ား	Noctuidae	Helicoverpa armigera (ရြက်လိပ်ိုး)	5.0	6.3

(ဤဇယားသည် ကျွန်ုပ်တို့၏ ၂၀၁၇ ခုနှစ် စစ်ေဆးေဖာ်ထုတ်မှုနှင့် ၁၉၉၉ ခုနှစ် မြန်မာ သီးနှံကာကွယ်ေရးဌာနခွဲ၏ စာအုပ်အေပါ် အေခြခံသည်။)

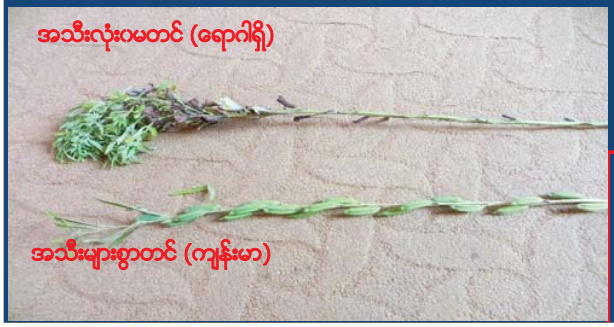
ပျိုးနှင့်ပိုင်းရပ်စ်

အကိုးအကား
ရောဂါပိုးသယ်ဆောင်သူဖြစ်နိုင်သည့် အရွယ်ရောက်ပြီး *Myzus persicae*

* ပိုင်းရပ်စ်ရောဂါရှိသောအပင်များသည် အသီးမတင်ဘဲ အထွက်နှုန်းလျော့သည်။
* ထိုပိုင်းရပ်စ်နှင့် ရောဂါပိုးသယ်ဆောင်သူအကြောင်း ကျွန်ုပ်တို့တွင် သတင်းအချက်အလက် မရှိသေးပါက် ဖြစ်သည်။
* အသေးစိတ် စစ်ဆေးဖော်ထုတ်မှုကို လိုအပ်သည်။

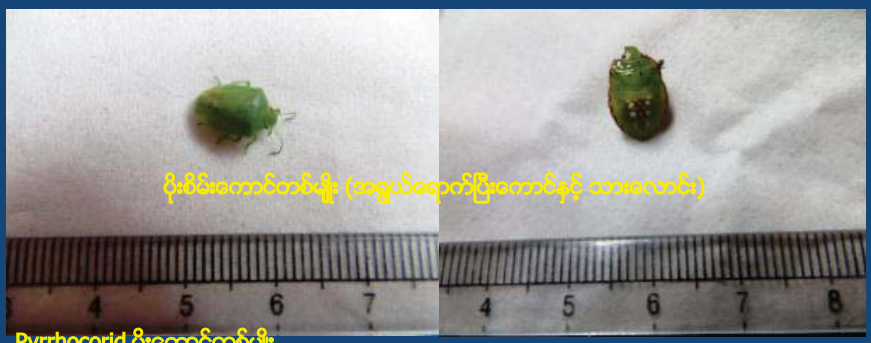
နံကောင်များနှင့် ဖိုင်တိုပလပ်စမာ (MLO)

Sesamun jassid
(အရွယ်ရောက်ပြီး - ရောဂါသယ်ဆောင်သူ)



စိုက်ခင်းထဲရှိ ရောဂါပိုးကူးစက်ခံရနှုန်း အမြင့်ဆုံး = ၄၇%

ပိုးစိမ်းကောင်များ, Pyrrhocorid ပိုးကောင်များနှင့် Lygaeid ပိုးကောင်များ



Pyrrhocorid ပိုးကောင်တစ်မျိုး
(*Dysdercus* spp.: အရွယ်ရောက်ပြီး)

ပိုးတောင်မာများ

နှမ်းပင်ဖျက်ပိုးတောင်မာအနက်
(သားလောင်းများ)

* ပိုးတောင်မာသားလောင်းများသည် နှမ်းပင်အမြစ်များကို ပြင်းထန်စွာ ထိခိုက်ပျက်စီးစေနိုင်သည်။


ပိုးစားထားသောအရွက်များ

ပိုင်ရာလစ်ဒ် ဖလံများ

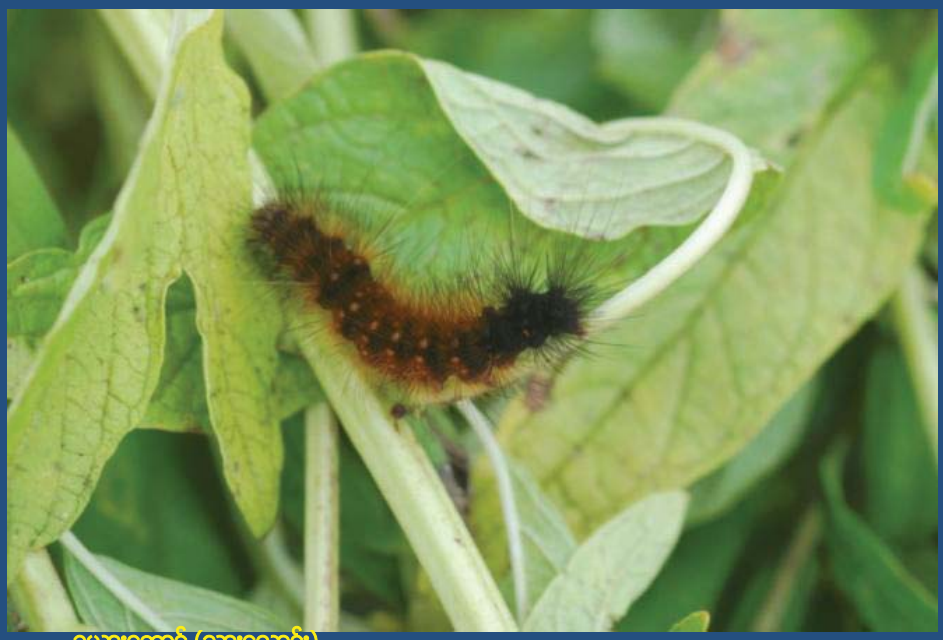

နှမ်းပင်ပုရောဂါပိုး (သားလောင်းများ)

စဖင့်စ် ဖလံများ

မြန်မာနိုင်ငံတွင် ရရှိသော သားလောင်းကောင်

အင်္ဂိုးအခကား
ဂျပန်နိုင်ငံတွင်ရရှိသော စဖင့်စ်ဖလံ တစ်မျိုး

ရွက်စုံစားဖလံများ



ခူယားကောင် (သားလောင်း)

(ဓာတ်ပုံ - Dr. Kuwahara)

ဇီးကွက်ပုံဖလံများ

ဇီးကွက်ပုံဖလံအမျိုးမျိုးတို့၏ သားလောင်းများ

* ရွက်လိပ်အိမ်ပုံး၊ အထွေထွေဖျက်ပိုးများကဲ့သို့သော ဇီးကွက်ပုံဖလံ အမျိုးကွဲများတို့သည် ကူးစက်ပျံ့နှံ့သွားသောအခြေအနေတွင် နှမ်းပင်များကို ပြင်းထန်စွာ ထိခိုက်စေသည်။

အဝါရောင်ကော်စေးထောင်ချောက်တွင် မိနေသည့် သေးငယ်သော အင်းဆက်များ

နှမ်းပင်ဖျက်ပိုး (အရွယ်ရောက်ပြီး)

* ၂၀၁၇ခုနှစ် ဖွန်နှင့် ဇုလိုင်တွင် နံကောင်များဖမ်းမိသော်လည်း အဝါရောင်ဖြင့်မျှားခေါ်နိုင်သော ပျိုးများ မဖမ်းမိပါ။

၄။ အဓိက သဘာဝရန်သူများ

ပိပိုးမှဉ်း Aphids (ဖိုင်းရပ္စ်ရောဂါမှဉ်း)	Aphididae	Myzus persicae (မကြွေနီစိမ်းပိပိုး)	0.0 (Virus 15.0)	0.0
ဒူဝံကောင်မှဉ်း Leafhoppers (Phytoplasma disease)	Cicadellidae	Orosius albicinctus (ဒူဝမ်းပင်စိမ်းပို့)	55.0 (Phytoplasma 52.5)	56.3
ပင်ဖျော့ကိုးမှဉ်း	Pentatomidae Pyrrhocoridae Lygaeidae	Nezara spp., Dysdercus spp., Aphamussordidus (ဒူဝမ်းစေ့ဖျော့ကိုး)	42.5	43.8
ပိုးတောင်ခွာမှဉ်း	Scarababidae	Anomala antiqua (ဒူဝမ်းပင်စိမ်းပိုးတောင်ခွာအနက်)	5.0	0.0
ပိုဇွာလစ္စ ဖလံမှဉ်း	Pyralidae	Antigastra catalaunalis (ဒူဝမ်းရင်လိပ်ပို့)	5.0	0.0
စဖင့်စ့် ဖလံမှဉ်း	Sphingidae	Acherontia styx (သေသမင်းခေါင်း ဖလံ)	0.0	6.3
ရင်ခွံစားဖလံမှဉ်း	Arcitiidae	Spilosoma obliqua (ခွေးသေကောင်)	5.0	0.0
ဇီးကြက်ငုဖလံမှဉ်း	Noctuidae	Helicoverpa armigera (ရင်လိပ်အိမ်ပို့)	5.0	6.3

ကပ်ပါး နကျယ်ကောင်များ

အကိုးအကား
Braconidae တစ်မျိုး

* Eulophidae နှင့် Braconidae တို့ကဲ့သို့သော ကပ်ပါးနကျယ် ကောင်များသည် လွန်စွာအရေးပါသော သဘာဝရန်သူများဖြစ်သည်။

ဖျက်ပိုးများ

* မြန်မာနိုင်ငံတွင် Miridae၊ Geocoridae နှင့် Reduvidae တို့ကဲ့သို့သော ဖျက်ပိုးများကိုတွေ့ရသည်။
* ဂျပန်နိုင်ငံတွင် ဆေးရွက်ကြီးစားပိုး (*Nesisiocoris tenuis*) ကို နှမ်းပင်များတွင် တွေ့ရသည်။

၅။ ပိုးမွှားနှိမ်နင်းရေးနည်းလမ်းများ (အထွေထွေ)

နှိမ်နင်းမှုနည်းလမ်း	ပင်မနည်းပညာ
ဓါတုဗေဒဆိုင်ရာနည်းလမ်း	စိုက်ပျိုးရေးသုံးဓာတုဆေးဝါး (ပိုးသတ်ဆေးများ)
ရုပ်ပိုင်းဆိုင်ရာနည်းလမ်း	ဖမ်းဆီးသတ်ဖြတ်ခြင်း၊ သီးခြားဖယ်ထားခြင်း၊ အလင်း၊အရောင်၊အပူဖြင့် စီမံခြင်း
သဘာဝနည်းလမ်း/ရိုးရာနည်းလမ်း	သီးနှံအလှည့်ကျစိုက်ပျိုးခြင်း၊ ရောနှောစိုက်ပျိုးခြင်း၊ သီးထပ်/သီးညှပ်စိုက်ပျိုးခြင်း၊ ထွန်ယက်ခြင်း၊ ရှင်းလင်းခြင်း၊ ကြားခံသီးနှံ၊ ရန်ဘက်သီးနှံ၊ တန်ပြန်ချိန်မှန် အမျိုးမျိုး
ဇီဝနည်းလမ်း	သဘာဝရန်သူ ပေါကြွားစေခြင်း၊ နယ်ခံသဘာဝရန်သူ၊ Pheromon ဖော့စပ်မှုများ၊ မျိုးရိုးဗီဇထိန်းချုပ်ခြင်း

ကျွန်ုပ်တို့တွင် နည်းလမ်းမြောက်များစွာရှိသည်!

ဓာတုဆေးဂါးနည်းလမ်း

မြန်မာနိုင်ငံရှိ နှမ်းသီးနှံဖျက်ပိုးမွှားများအတွက် အဓိက စိုက်ပျိုးရေး သုံးဓာတုဆေးဂါးများ

ပါဝင်သောဓာတုပစ္စည်းအမည်	ရောင်းကုန်အမည်	သြဇာပညတ်ရာဏာ
ဒယ်လ်တာမီသရင်း (Deltamethrin) ၂.၅% အီးစီ	ဒက်ဆစ် (Decis)	ဖန်ဆီးယူထားသော ပိုင်ရီသရွိုက် အင်းဆက်သတ်ဆေး (Synthetic pyrethroid insecticide)
ဒိုင်ယာဇီးနွန် (Diazinon) ၄၀% အီးစီ	ဒိုင်ယာဇီးနွန် (Diazinon)	အော်ဂဲနိုဖိုစဖော်ရပ် အင်းဆက်သတ်ဆေး (Organophosphorus insecticide)
ဒိုင်မီသိုအိတ် (Dimethoate) ၄၀% အီးစီ	ဒိုင်မသိုအိတ် (Dimathoate)	အော်ဂဲနိုဖိုစဖော်ရပ် အင်းဆက်သတ်ဆေး (Organophosphorus insecticide)
ဖဲန်းထရိုသီယွန် (Fenitrothion) ၅၀% အီးစီ	ဆူမီသီယွန် (Sumithion)	အော်ဂဲနိုဖိုစဖော်ရပ် အင်းဆက်သတ်ဆေး (Organophosphorus insecticide)
ဖဲန္ဒရိုပါသရင်း (Fenpropathrin) ၁၀% အီးစီ	ဒါနီတောလ် (Danitol)	ဖန်ဆီးယူထားသော ပိုင်ရီသရွိုက် အင်းဆက်သတ်ဆေး (Synthetic pyrethroid insecticide)
အိုင်ဒီဘကလိုပရစ် (Imidacloprid) ၇၀% ဒီ ်ွင့် ၇၀% ဒဗယ်လ်ပီ	Gaucho and DOZER	နီယိုနီကိုတီးပြိဖီတ် အင်းဆက်သတ်ဆေး (Neonicotinoid insecticide)
မာလာသီယွန် (Malathion) ၅၀% အီးစီ	မသီပါ	အော်ဂဲနိုဖိုစဖော်ရပ် အင်းဆက်သတ်ဆေး (Organophosphorus insecticide)
ဖဲန်သိုအိတ် (Phenthoate) ၅၀% အီးစီ	မသီပါ	အော်ဂဲနိုဖိုစဖော်ရပ် အင်းဆက်သတ်ဆေး (Organophosphorus insecticide)

(စိုက်ပျိုးရေးသုံးဓာတုဆေးဂါးများကို ၁၉၉၉ ခုနှစ် မြန်မာနိုင်ငံ သီးနှံကာကွယ်ရေးဌာနခွဲ၏ လက်ကမ်းစာစောင်ငယ်မှ ထုတ်နုတ်ဖော်ပြသည်။)

မှန်ကန်သောစိုက်ပျိုးရေးသုံး ဓာတုဆေးဂါးများကို မှန်ကန်စွာအသုံးပြုပါ။

- ဥပဒေနှင့်ညီသည့် တရားဝင်လမ်းကြောင်းများမှ မှန်ကန်သော စိုက်ပျိုးရေးဓာတုဆေးဂါးများကိုဝယ်ပါ။
- အညွှန်းစာများတွင် ဖော်ပြထားသည့် လမ်းညွှန်ချက်များကို

လိုက်နာပါ။

ရည်ရွယ်ထားသည့်အသီးအနှံများနှင့် ပိုးမွှားများ!

ရာသီရိန်နှင့်ပက်ဖျန်းရမည့် အကြိမ်နှုန်း!

မှန်ကန်သော ဖျော်စပ်မှု!

- ဓာတုဆေးဂါါပက်ဖျန်းထားသည့် နှမ်းများကို ထုတ်ကုန်အဖြစ် ရောင်းချခြင်း မပြုရ!

* ၄င်းတို့သည် ဘေးကင်းရေး (ဓာတုဆေးအကြွင်းအကျန်များ စသည်)၊ စရိတ်လျော့ချရေး၊ ပိုးမွှားနှိမ်နင်းမှုဆိုင်ရာ ထိရောက်မှုတို့နှင့် ဓာတုဆေး၏ထိရိုက်မှု ကာကွယ်ရေးအတွက် အရေးပါသည်။

ဇီဝဗေဒဆိုင်ရာ နည်းလမ်း

(၁) ဇီဝပိုးသတ်ဆေး

နီမတုတ် ပေါက်ဖွားစေသော ဆေးဂါး

- သဘာဝရန်သူ (နကျယ်ကောင်၊ ပိုးကောင်၊ ပင့်ကူငယ်များ၊ နီမ တုတ်များ စသည်) အမျိုးအစားပေါင်း များစွာတို့ကို ပေါက်ဖွားစေသော ဆေးဂါးများ ဈေးကွက်တွင်ရှိပါသည်။

(၂) ဒေသခံ သဘာဝရန်သူများ

- ဒေသခံ သဘာဝရန်သူများသည် စိုက်ခင်းများရှိ အင်းဆက် ပိုးမွှားများကို ထိန်းချုပ်သည်။
- အပင်များ (သီးနှံနှင့် ပေါင်းပင်များ) ကို စိုက်ခင်းများအတွင်းရှိ ၄င်းတို့၏ စားကျက်အဖြစ် စီမံပေးခြင်းဖြင့် ဒေသခံ သဘာဝရန်သူများကို ထိန်းသိမ်းပြီး ပျံ့နှံ့စေနိုင်သည်။

ရုပ်ပိုင်းဆိုင်ရာနည်းလမ်း

- အင်းဆက်ပိုးမွှားများကို ထိန်းချုပ်ရန်အတွက် အခြေခံနည်းလမ်း
- ပေါင်းပင်များနှင့် ရောဂါဖြစ်နေသောအပင်များကို ဖယ်ရှားခြင်း
- အင်းဆက်ပိုးမွှားများကို ဖမ်းဆီးသတ်ဖြတ်ခြင်း
- ရောင်ပြန်ပြားများ၊ အဂါရောင်အပြားများနှင့် ပိုက်ကွန်များ (ပိုးကောင်များအတွက် ၅ မီလီမီတာ ပိုက်ကွန်) ကို သုံးခြင်း

သဘာဝ (ရိုးရာ) နည်းလမ်း

- လူး၊ ဆတ်နှင့် ပြောင်း ကဲ့သို့သော ကြားခံသီနှံများသည် နှမ်းပင်များကို သေးငယ်သော အင်းဆက်ပိုးမွှားများရန်မှ ကာကွယ်ပေးသည်။

- အော်ဂဲနစ်ကြွယ်ဝသောမြေသည် အရွယ်ရောက်ပြီးပိုးတောင်မာများကို ဆွဲဆောင်တတ်သောကြောင့် ပို့က်ခင်းများ၏ မြေရှိ အော်ဂဲနစ်ပစ္စည်းများကို သင့်တင့်စွာ စီမံထိန်းသိမ်းခြင်းက အရေးပါလှသည်။

IPM ကိုစီစဉ်ခြင်း

- စုပေါင်းစပ်ပေါင်းပိုးမွှားနှိမ်နင်းရေး (IPM) ကိုနိုင်ငံတကာတွင် အသိအမှတ်ပြုကျင့်သုံးပါသည်။ ကမ္ဘာအရပ်ရပ်ရှိ သီးနှံပင်များကို ကာကွယ်ရာတွင် IPM သည် မရှိမဖြစ်လိုအပ်သည်။
- IPM ကို ဖွဲ့စည်းတည်ဆောက်ဆဲဖြစ်သော ဥယျာဉ်ခြံစိုက်ပျိုးရေးနည်းပညာတွင် တိုးချဲ့ထည့်သွင်းထားပါသည်။ နောင်တွင် ကွင်းဆင်းအခြေအနေများအောက်ရှိ ဥယျာဉ်ခြံစိုက်ပျိုးမှု နည်းပညာအထိပါ တိုးချဲ့ပါမည်။
- နိုင်ငံနှင့်ဒေသတစ်ခုချင်းစီရှိ စိုက်ပျိုးရေးဆိုင်ရာအခြေအနေကို အခြေခံပြီး IPM ဆိုင်ရာ နည်းပညာ အမျိုးမျိုးတို့ကို ပြုစုပျိုးထောင်သင့်သည်။
- IPM သည် ရှေးရိုး IPM မှ ဇီဝအဓိကထား IPM သို့ ဆင့်ကဲပြောင်းလဲနေပါသည်။

ဂျပန်နိုင်ငံရှိ IPM စနစ်

၂။ ပိုးမွှားများထိန်းချုပ်ရေးအတွက် သုံးသပ်ချက်များ

- တရားဝင်ကြိုတင်ခန့်မှန်းမှု သတင်းအချက်အလက်
- ပိုးမွှားကျရောက်မှု စစ်ဆေးချက်များ
- စီးပွားရေးထိခိုက်နိုင်သည့် အတိုင်းအတာ

၁။ ပိုးမွှားကျရောက်မှု ကြိုတင်သတ်ပေးချက်

- ရှေးရိုးထိန်းချုပ်ရေး နည်းလမ်းများ
- ခံနိုင်ရည် အမျိုးအစား အမျိုးမျိုး
- ဒေသခံ သဘာဝရန်သူများ
- ဖယ်ရှိမှုန်း (pheromone) ဖော်စပ်ထုတ်လုပ်ခြင်း

၃။ သင့်လျော်သည့်ထိန်းချုပ်ရေး နည်းလမ်းများအားလုံးကို အသုံးချခြင်း

- ဇီဝဗေဒဆိုင်ရာ ထိန်းချုပ်ရေး နည်းလမ်းများ
- ရုပ်ပိုင်းဆိုင်ရာ ထိန်းချုပ်ရေး နည်းလမ်းများ
- ဓာတုဗေဒဆိုင်ရာ ထိန်းချုပ်ရေး နည်းလမ်းများ

(၂၀၁၅ခုနှစ်၊ စိုက်ပျိုးရေး၊ သစ်တောနှင့်ငါးဖမ်းလုပ်ငန်း ဝန်ကြီးဌာနမှာကောက်နုတ်ဖော်ပြသည်။)

၆။ ပိုးမွှားနှိမ်နင်းရေးနည်းလမ်းများ (အတိအကျ)

ပျဉ်ပိုးနှင့် ပိုင်းရပ်စ်ရောဂါများ

- ရောဂါသယ်ဆောင်သူ ပျဉ်ပိုးများကို ထွန်ယက်စိုက်ပျိုးမှု အစောပိုင်းအဆင့်တွင်ပင် နှိမ်နင်းသင့်ပြီး ရောဂါဖြစ်နေသောအပင်များကို ရှင်းထုတ်ပစ်ရမည်။
- နှစ်စဉ် ရောဂါပိုးကျရောက်တတ်သည့် စိုက်ခင်းများတွင် ဓာတုဆေးဝါးများ ပက်ဖျန်းရမည်။
- မြန်မာနိုင်ငံ DOA နှင့် DAR က ထောက်ခံချက်ပေးထားသည့် ဓာတုဆေးဝါးများကို သုံးသင့်သည်။

နံကောင်များ (နှမ်းပင်ဖျက်ပိုး) နှင့် ဖိုင်တိုပလပ်စ်မာရောဂါ

- ရောဂါသယ်ဆောင်သူ နှမ်းပင်ဖျက်ပိုးများကို ထွန်ယက်စိုက်ပျိုးမှု အစောပိုင်းအဆင့်တွင်ပင် နှိမ်နင်းသင့်ပြီး ရောဂါဖြစ်နေသောအပင်များကို ရှင်းထုတ်ပစ်ရမည်။
- နှစ်စဉ် ရောဂါပိုးကျရောက်တတ်သည့် စိုက်ခင်းများတွင် ဓာတုဆေးဝါးများ ပက်ဖျန်းရမည်။
- မြန်မာနိုင်ငံ DOA နှင့် DAR ကထောက်ခံချက်ပေးထားသည့် ဓာတုဆေးဝါးများကို သုံးသင့်သည်။

ပင်ဖျက်ပိုးများ

- သာမန်ပေါ် ပေါက်သောအခြေအနေမျိုးတွင် ပင်ဖျက်ပိုးများကြောင့်ဖြစ်သော အပျက်အစီးကို လစ်လျူရှုထားနိုင်သည်။

ပိုးတောင်မာများ

- အော်ဂဲနစ်ကြွယ်ဝသောမြေသားသည် အရွယ်ရောက်ပြီး ပိုးတောင်မာများကို ဆွဲဆောင်သည်။
- အပင်များအနီးရှိ သားလောင်းလောက်ကောင်များကို ဖမ်းဆီးသတ်ဖြတ်သင့်သည်။
- မြေသားအတွင်းရှိ သားလောင်းလောက်ကောင်ကြောင့်ဖြစ်ပေါ် သော အတွင်းလှိုက်ပျက်စီးမှုကို ပိုပြင်းထန်သည်။
- ဆေးဖြန်းမည်ဆိုပါက မြန်မာနိုင်ငံ DOA နှင့် DAR ကထောက်ခံ ချက်ပေးထားသည့် ဓာတုဆေးဝါးများကို သုံးသင့်သည်။

ပိုင်ရာလစ်ဒ် ဖလံများ၊ စဖင့်စ်ဖလံများနှင့် ဇီးကွက်ပုံဖလံများ

- ဥငုံးဖလံအမျိုးအစားများ ပျံ့နှံ့မှုကို သတိထားစောင့်ကြည့်ရမည်ဖြစ်သော်လည်း သာမန်ပေါ် ပေါက်မှုအခြေအနေမျိုးတွင် အဆိုပါဖလံများကြောင့် ဖြစ်ပေါ် သော အပျက်အစီးကို လစ်လျူရှုနိုင်သည်။
- အပင်များပေါ်မှ သားလောင်းလောက်ကောင်များကို ဖမ်းဆီးသတ်ဖြတ်ရပါမည်။

တိုက်ဂါးဖလံများ

- သာမန်ပေါ် ပေါက်မှုအခြေအနေမျိုးတွင် တိုက်ဂါးဖလံများကြောင့်ဖြစ်ပေါ် သော အပျက်အစီးကို လစ်လျူရှုနိုင်သည်။
- အပင်များပေါ်မှ သားလောင်းလောက်ကောင်များကို ဖမ်းဆီး သတ်ဖြတ်ရပါမည်။

၇။ ပိုးမွှားပြဿနာများ

(၁) မြန်မာနိုင်ငံရှိ နှမ်းဖျက်ပိုးများ

- မြန်မာနိုင်ငံတွင် နှမ်းဖျက်ပိုးပြဿနာများ ပြင်းထန်ပါသည်။ ထိုပိုးမွှားပြဿနာကို စိုက်ပျိုးရေးသုံးဆောတွေးကြွင်းကျန်မှုကိုဖြစ်စေကြောင်း နားလည်သဘောပေါက်ရပါမည်။
- အဓိကနှမ်းဖျက်ပိုးများအကြောင်း သဘာဝပတ်ဝန်းကျင်ဆိုင်ရာ သတင်းအချက်အလက်သည် ပိုးမွှားနှိမ်နင်းရေးအတွက် မရှိမဖြစ်အရေးပါပါသည်။
- ပိုးမွှားကျရောက်မှုသည် တစ်နှစ်နှင့်တစ်နှစ် ကွဲပြားတတ်သောကြောင့် နှစ်စဉ် အဓိကနှမ်းဖျက်ပိုးမွှားများ၏ ရာသီအလိုက်ပြောင်းလဲမှုကို စစ်ဆေးဖော်ထုတ်ရပါမည်။

(၂) အစောပိုင်းအဆင့် - အင်းဆက်ပိုးမွှားများကြောင့် ပျံ့နှံ့ကူးစက်သော ဗိုင်းရပ်စ်နှင့် ဖိုင်တိုပလပ်စမာရောဂါများ

- ရောဂါသယ်ဆောင်သူ အင်းဆက်ကြောင့် ရောဂါကူးစက် ပျံ့နှံ့မှုသည် မြန်မာနိုင်ငံရှိ စိုက်ခင်းများစွာတို့တွင် ပေါ် ပေါက်နေပါသည်။

- နှမ်းပင်များတွင် အစောပိုင်းအဆင့် ရောဂါကူးစက်မှုဖြစ်ပေါ် နေပါသည်။ ထိုကြောင့် ရောဂါသယ်ဆောင်သူအင်းဆက်များဖြစ်သည့် ပျဝိုးများနှင့်နံကောင် (Jassid) များကို အစောပိုင်းအဆင့်တွင်ပင် နှိမ်နင်းရပါမည်။

- စိမ့်ဝင်နိုင်သော စိုက်ပျိုးရေးသုံးဓာတုဆေးများက ထိရောက်ပါသည်။ မျိုးစေ့ချခြင်းမပြုမီမျိုးစေ့များကို စိုက်ပျိုးရေးသုံးဓာတုဆေးဖြင့် စိမ်ခြင်းသည်လည်း ဓာတုဗေဒဆိုင်ရာနည်းလမ်းတစ်ခု အနေနှင့် ထိရောက်ပါသည်။

- ရောဂါကူးစက်ပျံနှံ့မှုကို ကာကွယ်ရန်အတွက် ရှုပ်ပိုင်းဆိုင်ရာ၊ နည်းလမ်းတစ်ရပ်အနေနှင့် ရောဂါဖြစ်ပွားနေသော အပင်များကို စိုက်ခင်းထဲမှ ဖယ်ရှားပစ်ရပါမည်။

- သဘာဝပတ်ဝန်းကျင်ဆိုင်ရာနှင့် ရိုးရာနည်းလမ်းတစ်ရပ်အနေနှင့် လူး၊ ဆတ်၊ ပြောင်းကဲ့သို့သော ကြွေးခံသီးနှံများက ပျံသန်းရောက်ရှိလာမည့် သေးငယ်သော အင်းဆက်ပိုးမွှားများကို တားဆီးပေးပါသည်။

(၃) နောက်ပိုင်းအဆင့် - ဂါးစားသည့်ပါးစပ်ပါသော Lepidopteran အင်းဆက်ပိုးမွှား

- Lepidopteran အင်းဆက်ပိုးမွှား အမျိုးအစားပေါင်းများစွာတို့သည် နောက်ပိုင်းအဆင့်တွင် ပေါ် ပေါက်သည်။

- ဖန်တီးယူထားသည့် pyrethroid နှင့် organophosphorus စိုက်ပျိုးရေးသုံးဓာတုဆေးဂါးများသည် ဓာတုဗေဒဆိုင်ရာ နည်းလမ်းအရ ထိရောက်မှုရှိသော်လည်း နောက်ပိုင်းအဆင့်တွင် ဓာတုဆေးဂါးများ ဖြန်းခြင်းကို ရှောင်ကျဉ်ရပါမည်။

- ရုပ်ပိုင်းဆိုင်ရာနည်းလမ်း တစ်ရပ်အနေနှင့် ဖမ်းဆီးသတ်ဖြတ်ခြင်းသည် ထိရောက်ပါသည်။ မဝေးတော့သည့်အနာဂတ်တွင် ဇီဝပိုးသတ်ဆေးများကို အသုံးပြုရန် လိုလားပါသည်။

- ပိုးတောင်မာသားလောင်းလောက်ကောင်များသည် မြေကြီးအတွင်းရှိ နှမ်းပင်အမြစ်များကို ပြင်းပြင်ထန်ထန်စားပစ်ကြသည်။ Organophosphorus စိုက်ပျိုးရေးသုံးဆေးဝါး (အစေ့ငယ်ပိုစ်) က ထိရောက်သော်လည်း ဓနာဂ်ပိုင်းအဆင့်တွင် ဓာတုဆေးများဖြန်းခြင်းကို ရှောင်ကျဉ်ရပါမည်။ Entomopathogenic nematodes ကဲ့သို့သော ဇီဝပိုးသတ်ဆေးသည် ဈေးကွက်တွင်ရှိပါသည်။

- အော်ဂဲနစ်မတ္တာများကြွယ်ဝသည့်မြေသားသည် အရွယ်ရောက်ပြီး ပိုးတောင်မာများ၏ ဥချမှုကို မြှင့်တင်ပေးသည်။

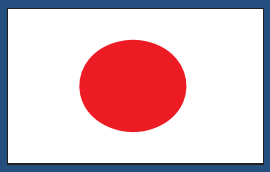
- ဓနာဂ်ပိုင်းအဆင့်တွင် ပိုးကောင်များနှင့် *Rhizoctonia* ရောဂါပေါ် ပေါက်သည့်အပြင် ဖိုင်တိုပလပ်စမာနှင့် ပိုင်းရပ်စ်ကြောင့် ဖြစ်သောရောဂါလက္ခဏာများကို အမှန်တကယ်ဖြစ်ပေါ် လာစေသည်။

(၄) အခြောက်စံအဆင့် - နှမ်းအထွက်နှုန်းကျခြင်း၊ ဖျက်ပိုးကဲ့သို့သော ပိုးမွှားများနှင့် ဓာတုဆေးဝါး အကြွင်းအကျန်များ

- အခြောက်လှန်းသည့်အဆင့်တွင် ပေါ် လာနိုင်သည့်ပိုးမွှားများကို ဓာတုဆေးဖြန်းခြင်း မပြုနိုင်သဖြင့် ကွင်းများတွင် အခြောက်လှန်းခြင်းကို ရှောင်ကျဉ်ရပါမည်။

- ထို့အပြင် နှမ်းအရည်အသွေးကျဆင်းခြင်းသည် ကွင်းပြင်များတွင် အခြောက်လှန်းစဉ် ပေါ် ပေါက်လေ့ရှိပါသည်။

- ကွင်းပြင်တွင် အခြောက်လှန်းခြင်းကို ပြန်လည်သုံးသပ်ရမည်ဖြစ်ပြီး အခြောက်လှန်းစနစ်သစ်များကို ထူထောင် အသုံးချရန် ရည်မှန်းထားရပါမည်။



အသိအမှတ်ပြုလွှာ

စိုက်ပျိုးရေးမွေးမြူရေးနှင့်ဆည်မြောင်းပန်ကြီးဌာန၊ မြန်မာ

လယ်ယာစိုက်ပျိုးရေးဌာန (DOA), ရုံးချုပ် DOA ဒေသဆိုင်ရာရုံး၊ မကွေးတိုင်းဒေသကြီး

စိုက်ပျိုးရေးသုတေသနဌာန (DAR), မကွေးတိုင်းဒေသကြီး ဆီထွက်သီးနှံသုတေသနဗဟိုဌာန DAR ရုံးချုပ်

နှမ်းစိုက်တောင်သူများနှင့် စိုက်ပျိုးရေးဓာတုဆေးအရောင်းဆိုင်များ

* ဤလမ်းညွှန်ကို ဂျပန်နိုင်ငံစိုက်ပျိုးရေး၊ သစ်တောနှင့် ငါးဖမ်းလုပ်ငန်းပန်ကြီးဌာနမှ ငွေကြေးထောက်ပံ့ပေးသည့် စီမံကိန်း၏ရလဒ်အပေါ် အခြေခံပြီး JAICAF ကရေးဆွဲသည်။

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