

Original Paper

Collaborative Survey and Collection of Brassica Vegetable Genetic Resources in Myanmar

Saki YOSHIDA ¹⁾, Hidehiko KIKUNO ¹⁾, Kenji WAKUI ²⁾,
Mami NAGASHIMA ¹⁾, Sander Moe ³⁾, Ohm Mar Saw ³⁾, Kenji IRIE ¹⁾

- 1) *International Agricultural Development, Graduate School of Agriculture, Tokyo University of Agriculture, Sakuragaoka 1-1-1, Setagaya, Tokyo 156-8502, Japan*
- 2) *Department of Bioresource Development, Faculty of Agriculture, Tokyo University of Agriculture, Hunakoshi 1737, Atugishi, Kanagawa 243-0034, Japan*
- 3) *Seed Bank, Biotechnology, Plant Genetic Resources and Plant Protection Division, Department of Agricultural Research, Ministry of Agriculture, Livestock and Irrigation, Yezin, Nay Pyi Taw, Myanmar*

Communicated by N. TOMOOKA (Genetic Resources Center, NARO)

Received Sep. 11, 2018, Accepted Jan. 4, 2019

Corresponding author: K. WAKUI (e-mail: wakuik@nodai.ac.jp)

Summary

An exploration and collection survey was conducted from December 20th, 2017, to January 15th, 2018, under collaboration between Tokyo University of Agriculture (TUA) and the Department of Agriculture Research (DAR), Myanmar. The surveyed areas were the Yangon Region, two townships in the Bago Region, Magway Region, Sagaing Region, three townships in Chin State, Mon State, and two townships in Kayin State, Myanmar. Genetic resources were collected from farmlands, farm houses, local markets and the areas surrounding the administrative offices of the Ministry of Agriculture, Livestock and Irrigation (MoALI). Seventy six samples were collected in total, including 43 *Brassica juncea*, 11 *Brassica oleracea* L. *Alboglabra* Group, 5 *Brassica oleracea* L. *Capitata* Group, and 15 *Raphanus sativus* L. and two of *R. sativus* L. var. *caudatus*. The collected genetic resources were divided between the Myanmar Seed Bank and the TUA; those taken to Japan were done as per the Standard Material Transfer Agreement. *B. juncea* has been used for various purposes, including as a leaf vegetable, for pickles and oil, as observed in the reports of previous investigations. However, in Chin State, mustard was mainly used for preserved meals and mustard oil was not widely cultivated. In addition, we observed propagation methods not found in other areas, such as propagation with cuttings, due to the perennial natures of cabbages and kailan.

KEY WORDS: Myanmar, Chin State, vegetable genetic resources, *Brassica juncea*

Introduction

Myanmar is located in Southeast Asia between the latitudes 09°32'N to 28°31'N and the longitudes from 92°10'E to 101°11'E. The longest river in Myanmar is the Ayeyarwady River, which flows through the country in a north to south direction. Soil from the Ayeyarwady riverbed collects in the Irrawaddy delta, producing fertile land in the process. Myanmar has three seasons, roughly classified as, summer from March to mid-May, rainy from mid-May to the end of October, and winter from November to February. The average highest temperature in central Myanmar during the summer is 43.3 °C, while in Northern Myanmar, it is 36.1 °C. Although Myanmar is almost completely covered by tropical habitats, a wide range of climatic conditions exists because of its location and topography. Due to the diverse climate and culture, Myanmar is expected to possess numerous genetic resources. However, previous reports on the survey and collection of genetic resources are inadequate at there.

In 2013, the Ministry of Agriculture, Forestry and Fisheries (MAFF), Japan and Genetic resources center, National Agriculture and Food Research Organization (NARO: Reorganization from National Institute of Agrobiological Sciences) started a 5-year project, 'Collaborative Research Project on Characterization and Evaluation of Plant Genetic Resources for Food and Agriculture' to promote the survey, characterization and evaluation of plant genetic resources in some Asian countries, Plant Genetic Resources in Asia (PGRAsia). Genetic Resources Center, NARO organized a joint research group with public agricultural research institutes and universities to implement this project. NARO has now concluded a joint research contract with Tokyo University of Agriculture (TUA) for the PGRAsia project. Collaborative exploration and collection by the Department-of-Agriculture-Research (DAR), Ministry of Agriculture, Livestock and Irrigation (MoALI), Myanmar and the TUA for vegetable genetic resources, particularly for Brassicaceae family vegetables, was organized for Myanmar, within the framework of the PGRAsia Project.

According to a national survey, plants belonging to Brassicaceae, especially *Brassica juncea* L., are widely cultivated and used in Myanmar (Ishida *et al.* 2000). In 2015, a collaborative survey to collect vegetable genetic resources, especially those of *Brassica* vegetables, was conducted mainly in the mountainous and hilly areas of the southern part of Shan State and part of Kayah State (Wakui *et al.* 2016), and in 2016, surveys in Kachin State and Sagain Region were conducted by Yoshida *et al.* (2017). Both surveys in 2015 and in 2016 indicated that *B. juncea* was used as a fresh and dry leaf vegetable, for pickles, as an edible oil and an essential oil for cosmetic purposes in each region of Myanmar. Most of the *B. juncea* vegetables were native varieties that had been cultivated in the area for a long time. In the southern part of Shan State, most of the *B. oleracea* vegetables, such as cabbage, cauliflower and Chinese kale, served as important cash crops, and were improved varieties that had been introduced from foreign countries (Wakui *et al.* 2016). On the other hand, in Kachin State and Sagain Region, vegetables such as cabbage or cauliflower were not registered, while Chinese kale had been cultivated and recognized as an important high-cash crop (Yoshida *et al.* 2017). The collected *R. sativus* samples were landraces, mostly consumed locally as oilseeds and root vegetables.

A large diversity of *B. juncea* with different morphological and physiological characteristics and quality traits were observed in this survey. However, the surveyed areas in Myanmar are still limited and do not cover the entire country. Therefore, in this survey, we aimed to explore areas that had, until now, not been surveyed, such as Chin State.

Methods

Exploration and collection surveys were carried out from the 20th December 2017 to 15th January 2018. Selected areas for this study were Yangon Region, Bago Region, Magway Region, Sagaing Region, Chin State, Mon State and Kayin State (Table 1). Genetic resources were collected from farmlands, farmer's houses (Photo 1) and local markets (Photo 2). Data such as variety name, cultivation time, usage method, price and history of samples were collected from the markets and fields, as well as their morphology, surrounding environments and the exact location (latitude / longitude / altitude) of the field. Myanmar has area administrative offices and satellite fields of the DAR, MoALI in each area that carry out seed production activities and breeding improvement programs. They possessed the traditional varieties passaged for a long time and so we were able to obtain seeds from their collections. In addition, some samples that were collected were just a piece of the stem of the plant from the farmer's house and they were further cultivated in a greenhouse in Atsugi, Kanagawa, Japan.

This survey was conducted under Prior Informed Consent (PIC) between the Seed Bank of MoALI of Myanmar and the TUA for the PGRAsia Project. Collected genetic resources were divided between the Myanmar Seed Bank and the TUA for the PGRAsia Project, and half of them were introduced to Japan with the Standard Material Transfer Agreement (SMTA) of the International Treaty on Plant Genetic Resources for Food and Agriculture.

Table 1. Itinerary for collaborative exploration and collection of genetic resources in 2017

Day	Date	Route	Stay	Activities
1	20-Dec-17	WED NH813 NRT 1100 - RGN 1640	YANGON	Transfer
2	21-Dec-17	THU YANGON - TOUNGOO	TOUNGOO	Exploration & Collection (Yangon, Toungoo)
3	22-Dec-17	FRI TOUNGOO - YEZIN	YEZIN	Exploration & Collection (Toungoo, Zeya Thiri)
4	23-Dec-17	SAT YEZIN	YEZIN	Visit to DAR ¹⁾
5	24-Dec-17	SUN YEZIN - MONYWA	MONYWA	Exploration & Collection (Monywa)
6	25-Dec-17	MON MONYWA - KALAYMYO	KALAYMYO	Exploration & Collection (Kalaymyo)
7	26-Dec-17	TUE KALAYMYO - TEDIM	TEDIM	Exploration & Collection (Tedim)
8	27-Dec-17	WED TEDIM - TONZANG - TEDIM	TEDIM	Exploration & Collection (Tedim)
9	28-Dec-17	THU TEDIM - FALAM	FALAM	Exploration & Collection (Tedim,Falam)
10	29-Dec-17	FRI FALAM	FALAM	Exploration & Collection (Falam)
11	30-Dec-17	SAT FALAM - HAKHA	HAKHA	Exploration & Collection (Falam,Haka)
12	31-Dec-17	SUN HAKHA	HAKHA	Exploration & Collection (Haka)
13	01-Jan-18	MON HAKHA - MONYWA	MONYWA	Exploration & Collection (Haka, Gangow)
14	02-Jan-18	TUE MONYWA - YEZIN	YEZIN	Exploration & Collection (Yezin)
15	03-Jan-18	WED YEZIN	YEZIN	Visit to DAR
16	04-Jan-18	THU YEZIN - YANGON	YANGON	Exploration & Collection (Yangon)
17	05-Jan-18	FRI YANGON - MALAMYINE	MALAMYINE	Exploration & Collection (Malamyine)
18	06-Jan-18	SAT MALAMYINE - HPAAN	HPAAN	Exploration & Collection (HpaanKyaik Mayaw)
19	07-Jan-18	SUN HPAAN - MYAWADI - HPAAN	HPAAN	Exploration & Collection (Myawadi)
20	08-Jan-18	MON HPAAN - YANGON	YANGON	Exploration & Collection (Hpaan)
21	09-Jan-18	TUE Surrounding YANGON	YANGON	Preparation
22	10-Jan-18	WED YANGON - ALLANMYO	ALLANMYO	Exploration & Collection (Allamyo)
23	11-Jan-18	THU ALLANMYO - PYAY	PYAY	Exploration & Collection (Pyay)
24	12-Jan-18	FRI PYAY - YANGON	YANGON	Exploration & Collection (Pyay)
25	13-Jan-18	SAT YANGON	YANGON	Transfer
26	14-Jan-18	SUN NH814 RGN 2210 -	on board	Transfer
27	15-Jan-18	MON - NRT NH814 06:45		

¹⁾ DAR: Department of Agriculture Research

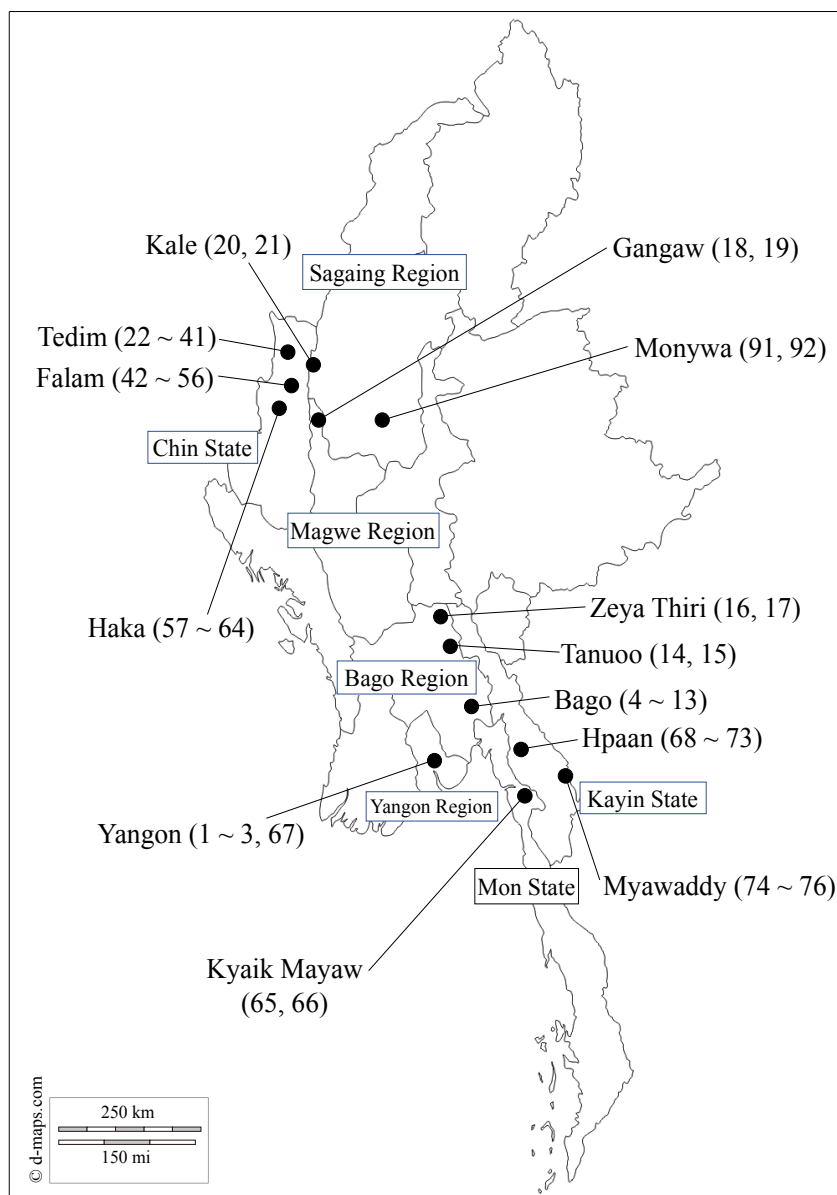


Fig. 1 Collection sites of Brassicaceae in Myanmar

The brackets indicate the collection number of the collected genetic resources.

Results and Discussion

The surveyed areas were Yangon Region, two townships in Bago Region, Magway Region, Sagaing Region, three townships in Chin State, Mon State, and two townships in Kayin State, ranging from 16° 22' 09" N-23° 25' 24" N to 93° 34' 08" E-98° 30' 02" E and from 15 m to 2,306 m in altitude (Fig. 1). The total number of collected samples was 76, including: 43 *Brassica juncea*, 11 *B. oleracea* L. *Alboglabra* Group, 5 *B. oleracea* L. *Capitata* Group, 15 of *Raphanus sativus* L. and 2 of which were *R. sativus* L. var. *caudatus* (Table 2).

(1) Chin State

Chin State is located in the western part of Myanmar, and India is to its north and west. It is primarily a mountainous area, and the survey areas were Haka, Tedim and Falam at altitudes of 1,206 m to 2,306 m. During the winter, the average temperature of these regions is below 4.4 °C, and fall as low as

freezing point of water in the higher altitude towns, such as Haka (Thant *et al.* 2002).

Although *B. juncea*, kailan and cabbage were cultivated in Chin State, root vegetables, such as radish, were not cultivated or used as much.

The cultivation of *B. juncea* on the mountain slopes of Chin State was frequent (Photos 3 and 4), especially when co-cultivated with garlic in terrace farms; *B. juncea* was planted on the terrace edges for weed control, to prevent structural collapses, and for effective utilization of space (Photos 5 and 6). It was also confirmed that *B. juncea* was cultivated in table gardens for domestic consumption (Photo 7). In villages where water storage was possible, it was grown all year round, whereas in other areas, it was cultivated only during the rainy season.

B. juncea as a crop was found to have multiple uses in these sampled regions, as was found in previous surveys; apart from being considered a fresh vegetable (Photo 8), it was used widely as a preserved food in both dried (Photo 9) or pickled forms (Photo 10). The pickled products are made from mustard leaves simply cut to appropriate sizes, dried, and then mixed with rice juice, ginger, salt and pickled in a container (Photo 11). Unlike areas from previous surveys, *B. juncea* in the Chin State was not widely used as an oil crop, owing to the oils for edible and liniment purposes were sourced from kailan in this region.

Traditional cabbages, called “Tim Gawphi” or “An Gawphi”, were found to be cultivated in local gardens (Sample No. 29, 37, 40 and 41; Table 2), they grow to about 150 cm with perennial cabbages (Photos 12 and 13). Their younger soft leaves are edible, while the older leaves harden and are used as livestock feed. Cabbage flowering in Chin State is difficult due to short days and seeds can only be harvested once every three years. Therefore, proliferation by cutting is generally performed. The samples cultivated in Japan bloomed in May, and confirmed the hypothesis that they require long-day-length conditions to induce flowering (Sample No. 29). This characteristic was not found in other samples from Myanmar, such as the perennial kailan (Sample No. 64; Photo 14), and *Brassica* vegetables called “France” or “Indian kale” that were sampled (Sample No. 44, 49 and 53; Photo 15).

(2) Bago Region

The Bago Region is located in the south of the big central plains. The southern part of the region experiences tropical monsoons and the northern part has a tropical savanna climate.

In the Bago Region markets there were two types of mustards regularly sold: one was white with a middle rib and the other was green (Photo 16). There were also an abundance of radishes being sold, many to be used as root vegetables (Photo 17), while the roots of some varieties did not bloat and it was their above-ground leafy parts that were desirable (No. 13 and 14; Photos 18 and 19).

In the vicinity of the Irrawaddy River, we observed commercial cultivation of mustards at the bottom of the riverbed when approaching the dry season, improved varieties of the crop were used, and conventional varieties were not found to be cultivated (Photos 20-22).

(3) Mon State and Kayin State

Mon State has a tropical climate but the annual fluctuations of temperature are generally small. The average temperature of the capital city, Mawlamyine, is 25.6 °C in January and 29.4 °C in April. Kayin State has a hot and humid climate because of the surrounding mountain ranges and foehn winds.

In these two states, the cultivation of leafy vegetables, including mustards, was less than in the other

areas sampled as leafy vegetables were difficult to cultivate in high temperature areas. Instead of mustard, they cultivated improved varieties of cabbage and cauliflower (Photo 23), introduced from Thailand. However, in the local market shops, traditional varieties of mustards and radishes had been sold (No. 68-76); the shop owner informed us that their cultivation continues in the villages located a little further from the highway. Improved cultivars from Thailand were introduced three years ago and they would be expected to permeate in the future; therefore, it is necessary to survey and collect genetic resources as soon as possible.

Acknowledgments

This work was supported by the grant for the PGRAsia Project from the Ministry of Agriculture, Forestry and Fisheries of the Government of Japan.

References

- Ishida M, Tetuka T, Irie K, Tin Maw Oo, Thein Zaw and Kyaw Soe (2000) Preliminary survey for exploration and collection of small grain germplasm and industrial crop in Myanmar. AREIPGR 16: 153-163 (in Japanese with English summary).
- Myo Thant, Maung Hlaing, Soe Myint and Tin Tin Win (2002) MYANMAR, Facts and Figures 2002. "STATES AND DIVISIONS". Ministry of Information Union of Myanmar, Yangon, pp. 31-52.
- Wakui K, Irie K, Ohm Mar Saw and Than Than Naing Oo (2016) Collaborative survey and collection of brassica vegetable genetic resources in and around the southern Shan State of Myanmar. AREIPGR 32: 243-261.
- Yoshida S, Kikuno H, Nagashima S, Than Naing Oo, Ohm Mar Saw and Irie K (2017) Exploration and collection of vegetable genetic resources within Brassicaceae in and around Kachin State of Myanmar. AREIPGR 33: 223-237.

ミャンマーにおけるアブラナ科遺伝資源の 共同探索および収集

吉田 沙樹¹⁾・菊野 日出彦¹⁾・和久井 健司²⁾・長嶋 麻美¹⁾・
Sander Moe³⁾・Ohm Mar Saw³⁾・入江 憲治¹⁾

1) 東京農業大学 大学院 農学研究科 国際農業開発学専攻

2) 東京農業大学 農学部 生物資源開発学科

3) ミャンマー農業畜産灌漑省 農業研究局 バイオテクノロジー・植物遺伝資源・植物
保護課 シードバンク

和文摘要

ミャンマー連邦共和国において、2017年12月20日から2018年1月15日にかけて、カラシナを中心としたアブラナ野菜の遺伝資源探索収集調査を実施した。調査はチン州を中心に、ヤンゴン地方域、バゴー地方域、マグウェイ地方域、ザガイン地方域、モン州、カヤイン州に於いて行った。その結果、カラシナ類43点、キャベツ類の16点、ダイコン類17点を含む76点の遺伝資源を収集した。収集品は2分し、一方はミャンマー農業畜産灌漑省農業研究局・シードバンクで、他方は国際および国内法に従って日本に導入され、農業・食品産業技術総合研究機構・遺伝資源センターにて保存される。

チン州においてもカラシナは常用野菜として用いられていたが、冬季は氷点下まで気温が下がる気候の影響か、漬物および乾燥野菜といった保存食としての活用が目立った。油としての利用も行われているが、カラシナよりもカイランが多く用いられていた。また、多年生のキャベツおよびカイランが観察され、挿し木による栄養繁殖が頻繁に行われていた。

Table 2. A list of plant materials collected in 2017

Coll. No.	JP No.	Species	Local name	Date of collection	Collection sites	Township	Name of village / market	Latitude	Longitude	Altitude (m)	Collection source	Usage
01	261404	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	21-Dec-17	Yangon Region	Yangon	Htauk kyat market	17.04263	96.13344	10	commercial market	leaf vegetable
02	261405	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	21-Dec-17	Yangon Region	Yangon	Htauk kyat market	17.04263	96.13344	10	commercial market	leaf vegetable
03	261406	<i>Raphanus sativus</i> L. var. <i>caudatus</i>	Mon len u	21-Dec-17	Yangon Region	Yangon	Htauk kyat market	17.04263	96.13344	10	commercial market	fruit
04	261407	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	21-Dec-17	Bago Region	Bago	Bago market	17.33453	96.48008	36	commercial market	vegetable
05	261408	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	Kai lan	21-Dec-17	Bago Region	Bago	Bago market	17.33453	96.48008	36	commercial market	vegetable
06	261409	<i>Raphanus sativus</i> L.	Mon len u	21-Dec-17	Bago Region	Bago	Bago market	17.33453	96.48008	36	commercial market	vegetable
07	261410	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	21-Dec-17	Bago Region	Bago	Bago market	17.33453	96.48008	36	commercial market	leaf vegetable
08	261411	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	21-Dec-17	Bago Region	Bago	Bago market	17.33453	96.48008	36	commercial market	leaf vegetable
09	261412	<i>Raphanus sativus</i> L.	Mon len u	21-Dec-17	Bago Region	Bago	Bago market	17.33453	96.48008	36	commercial market	leaf vegetable
10	261413	<i>Raphanus sativus</i> L.	Mon len u	21-Dec-17	Bago Region	Bago	Bago market	17.33453	96.48008	36	commercial market	root vegetable
11	261414	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	21-Dec-17	Bago Region	Bago	Bago market	17.33453	96.48008	36	commercial market	vegetable
12	261415	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	Kai lan	21-Dec-17	Bago Region	Bago	Bago market	17.33453	96.48008	36	commercial market	vegetable
13	261416	<i>Raphanus sativus</i> L.	Mon len u	21-Dec-17	Bago Region	Bago	Bago market	17.33453	96.48008	36	commercial market	leaf vegetable
14	261417	<i>Raphanus sativus</i> L.	Mon len u	22-Dec-17	Bago Region	Bago	Tanuoo	18.94166	96.43811	53	commercial market	leaf vegetable
15	261418	<i>Raphanus sativus</i> L.	Mon len u	22-Dec-17	Bago Region	Bago	Tanuoo	18.94166	96.43811	53	commercial market	leaf vegetable
16	261419	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	23-Dec-17	Bago Region	Zeya Thiri	Yezin market	19.84897	96.26203	-	commercial market	leaf vegetable
17	261420	<i>Raphanus sativus</i> L.	Mon len u	23-Dec-17	Bago Region	Zeya Thiri	Yezin market	19.84897	96.26203	-	commercial market	root vegetable
18	261421	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	25-Dec-17	Magway Region	Gangaw	Kwan dap village	22.27500	94.11861	209	farmland	vegetable
19	261422	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	25-Dec-17	Magway Region	Gangaw	Kwan dap village	22.27500	94.11861	209	farmland	vegetable
20	261423	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	26-Dec-17	Sagaing Region	kale	Tahar market	23.20071	94.01521	992	commercial market	vegetable
21	261424	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin phe	26-Dec-17	Sagaing Region	kale	Tahar market	23.20071	94.01521	992	commercial market	vegetable
22	261425	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin sein	26-Dec-17	Chin state	Tedim	Tai Negen village	23.21263	93.80858	1,903		vegetable
23	261426	<i>Brassica oleracea</i> L. <i>Capitata</i> Group	Gawphi	26-Dec-17	Chin state	Tedim	Tai Negen village	23.21263	93.80858	1,903		leaf vegetable
24	261427	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	27-Dec-17	Chin state	Tedim	Tedim	-	-	-	office	vegetable
25	261428	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	27-Dec-17	Chin state	Tedim	Tedim	-	-	-	office	vegetable
26	261429	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	Kai lan	27-Dec-17	Chin state	Tedim	Ngen Nurung village	23.64167	93.75000	1,206		vegetable / oil
27	261430	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	27-Dec-17	Chin state	Tedim	Ngen Nurung village	23.64167	93.75000	1,206		vegetable / oil
28	261431	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	27-Dec-17	Chin state	Tedim	Tual Zang village	23.42328	93.65082	1,308	farmland	vegetable
29	261432	<i>Brassica oleracea</i> L. <i>Capitata</i> Group	An gawphi	27-Dec-17	Chin state	Tedim	Tual Zang village	23.42328	93.65082	1,308	farmland	vegetable
30	261433	<i>Raphanus sativus</i> L. var. <i>caudatus</i>	Mon Hnyin	27-Dec-17	Chin state	Tedim	Siang sawn village	23.39535	93.66994	1,627	farmland	vegetable
31	261434	<i>Brassica juncea</i> (L.) Czern.	France	27-Dec-17	Chin state	Tedim	Siang sawn village	23.39535	93.66994	1,627	farmland	vegetable
32	261435	<i>Brassica juncea</i> (L.) Czern.	Kai lan	28-Dec-17	Chin state	Tedim	Tiddin Market	23.37953	93.65470	1,662	commercial market	vegetable
33	261436	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	28-Dec-17	Chin state	Tedim	Akr Luai village	23.27769	93.76686	2,306	farmland	vegetable
34	261437	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	Kai lan	28-Dec-17	Chin state	Tedim	Valuag village	23.13734	93.74765	2,034	farmland	vegetable
35	261438	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	Kai lan	28-Dec-17	Chin state	Tedim	Valuag village	23.13734	93.74765	2,034	farmland	vegetable
36	261439	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	Kai lan	28-Dec-17	Chin state	Tedim	Valuag village	23.13734	93.74765	2,034	farmland	vegetable
37	261440	<i>Brassica oleracea</i> L. <i>Capitata</i> Group	Gawphi	28-Dec-17	Chin state	Tedim	Valuag village	23.13734	93.74765	2,034	farmland	vegetable
38	261441	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	28-Dec-17	Chin state	Tedim	Valuag village	23.13734	93.74765	2,034	farmland	vegetable
39	261442	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	Kai lan	28-Dec-17	Chin state	Tedim	Lone Ban village	22.99932	93.69186	1,291	farmland	vegetable / oil
40	261443	<i>Brassica oleracea</i> L. <i>Capitata</i> Group	Tim Gawphi	28-Dec-17	Chin state	Tedim	Lone Ban village	22.99932	93.69186	1,291	farmland	vegetable
41	261444	<i>Brassica oleracea</i> L. <i>Capitata</i> Group	Gawphi	28-Dec-17	Chin state	Tedim	Lone Ban village	22.99932	93.69186	1,291	farmland	vegetable

Table 2. (Continued).

Coll. No.	JP No.	Species	Local name	Date of collection	Collection sites	Township	Name of village / market	Latitude	Longitude	Altitude (m)	Collection source	Usage
42	261445	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	Kai lan	29-Dec-17	Chin state	Falam	Tai Sun village	22.92951	93.69336	1,185	farmland	vegetable
43	261446	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	29-Dec-17	Chin state	Falam	Tai Sun village	22.93234	93.69406	1,141	farmland	vegetable
44	261447	<i>Brassica juncea</i> (L.) Czern.	France	29-Dec-17	Chin state	Falam	Tai Sun village	22.93234	93.69406	1,141	farmland	vegetable
45	261448	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	29-Dec-17	Chin state	Falam	Falam Market	22.91120	93.68025	1,510	commercial market	vegetable
46	261449	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	29-Dec-17	Chin state	Falam	Falam Market	22.91120	93.68025	1,510	commercial market	vegetable
47	261450	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	30-Dec-17	Chin state	Falam	Falam Market	22.91120	93.68025	1,510	commercial market	vegetable
48	261451	<i>Raphanus sativus</i> L.	Mon len u	30-Dec-17	Chin state	Falam	Falam Market	22.91120	93.68025	1,510	commercial market	vegetable
49	261452	<i>Brassica juncea</i> (L.) Czern.	France	30-Dec-17	Chin state	Falam	Falam Market	22.91120	93.68025	1,510	commercial market	vegetable
50	261453	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	30-Dec-17	Chin state	Falam	Falam Market	22.91120	93.68025	1,510	commercial market	vegetable
51	261454	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	30-Dec-17	Chin state	Falam	Falam Market	22.91120	93.68025	1,510	commercial market	vegetable
52	261455	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	30-Dec-17	Chin state	Falam	Falam Market	22.91120	93.68025	1,510	commercial market	vegetable
53	261456	<i>Brassica juncea</i> (L.) Czern.	France Mon Hnyin	30-Dec-17	Chin state	Falam	Falam Market	22.91120	93.68025	1,510	commercial market	vegetable
54	261457	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	30-Dec-17	Chin state	Falam	Falam Market	22.91120	93.68025	1,510	commercial market	vegetable
55	261458	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	30-Dec-17	Chin state	Falam	Falam Market	22.91120	93.68025	1,510	commercial market	vegetable
56	261459	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	Kai lan	30-Dec-17	Chin state	Falam	Falam Market	22.91120	93.68025	1,510	commercial market	vegetable
57	261460	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	30-Dec-17	Chin state	Haka	Chungung village	22.76587	93.56883	1,642	farmland	vegetable
58	261461	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	31-Dec-17	Chin state	Haka	Li Nam village	22.48606	93.76965	1,262	farmland	vegetable
59	261462	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	31-Dec-17	Chin state	Haka	Lam Tuk village	22.48072	93.80001	1,225	farmland	vegetable
60	261463	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	31-Dec-17	Chin state	Haka	Lam Tuk village	22.48072	93.80001	1,225	farmland	vegetable
61	261464	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	31-Dec-17	Chin state	Haka	Lam Tuk village	22.48072	93.80001	1,225	farmland	vegetable
62	261465	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	31-Dec-17	Chin state	Haka	Rua Van village	22.51199	93.74212	1,484	farmland	vegetable
63	261466	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	31-Dec-17	Chin state	Haka	Nay Pyae village	22.58731	93.62815	2,009	farmland	vegetable
64	261467	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	Kai lan	31-Dec-17	Chin state	Haka	Nay Pyae village	22.58731	93.62815	2,009	farmland	vegetable
65	261469	<i>Raphanus sativus</i> L.	Mon len u	6-Jan-18	Mon state	Kyaik Mayaw	Kyaik Mayaw	16.36917	97.72500	15	commercial market	vegetable
66	261470	<i>Raphanus sativus</i> L.	Mon len u	6-Jan-18	Mon state	Kyaik Mayaw	Kyaik Mayaw	16.36917	97.72500	15	commercial market	leaf vegetable
67	261471	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	26-Dec-18	Yangon Region	Yangon	Myoy paday thar kyun market	-	-	-	commercial market	vegetable
68	261472	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	7-Jan-18	Kayin state	Hpaan	Hpaan market	16.89195	97.63498	17	commercial market	leaf vegetable
69	261473	<i>Raphanus sativus</i> L.	Mon len u	7-Jan-18	Kayin state	Hpaan	Hpaan market	16.89195	97.63498	17	commercial market	leaf vegetable
70	261474	<i>Raphanus sativus</i> L.	Mon len u	7-Jan-18	Kayin state	Hpaan	Hpaan market	16.89195	97.63498	17	commercial market	root vegetable
71	261475	<i>Raphanus sativus</i> L.	Mon len u	7-Jan-18	Kayin state	Hpaan	Hpaan market	16.89195	97.63498	17	commercial market	leaf vegetable
72	261476	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	7-Jan-18	Kayin state	Hpaan	Hpaan market	16.89195	97.63498	17	commercial market	vegetable
73	261477	<i>Raphanus sativus</i> L.	Mon len u	7-Jan-18	Kayin state	Hpaan	Hpaan market	16.89195	97.63498	17	commercial market	root vegetable
74	261478	<i>Brassica juncea</i> (L.) Czern.	Mon Hnyin	8-Jan-18	Kayin state	Myawaddy	Myawaddy maket	16.68794	98.50063	205	commercial market	leaf vegetable
75	261479	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	Kai lan	8-Jan-18	Kayin state	Myawaddy	Myawaddy maket	16.68794	98.50063	205	commercial market	leaf vegetable
76	261480	<i>Raphanus sativus</i> L.	Mon len u	8-Jan-18	Kayin state	Myawaddy	Myawaddy maket	16.68794	98.50063	205	commercial market	leaf vegetable



Photo 1. Seeds of *Brassica juncea* kept in farmhouse at Tedim Township



Photo 2. Seed shop in the Bago local market



Photo 3. Large-scale cultivation of *Brassica juncea* using mountain slopes in Chin State (1)



Photo 4. Large-scale cultivation of *Brassica juncea* using mountain slopes in Chin State (2)



Photo 5. Planted *Brassica juncea* on the terrace edge in Chin State (1)



Photo 6. Planted *Brassica juncea* on the terrace edge in Chin State (2)



Photo 7. *Brassica juncea* growing up in the table garden, Tual zang village, Tedim Township



Photo 8. Stir-fried vegetables with *Brassica juncea*



Photo 9. Dried *Brassica juncea*



Photo 10. Pickles of *Brassica juncea*



Photo 11. *Brassica juncea* in the midst of picking, Ngen Nurung village, Tedim Township



Photo 12. Perennial cabbage, Tedim Township



Photo 13. Perennial cabbage grown to 150 cm, Tedim Township



Photo 14. Perennial Kailan, Tedim Township



Photo 15. Left: kailan, Center: "France", Light: mustard, Falam market



Photo 16. White or green type of the midrib, Bago market



Photo 17. *Raphanus sativus* sold in the Bago market



Photo 18. *Raphanus sativus* that is able to eat the flower sold in the Toungoo market



Photo 19. *Raphanus sativus* that is able to eat the leaf sold in the Bago market



Photo 20. Aerial photo of the state of the river and sandbank in the dry season



Photo 21. View of the farmland in sandbank in a river



Photo 22. Cultivated *Brassica juncea* at sandbank in a river



Photo 23. Cauliflower production in the Malamyine market