

Collaborative Survey and Collection of Brassica Vegetable Genetic Resources in Myanmar in 2018 and 2019

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Original Paper

Collaborative Survey and Collection of *Brassica* Vegetable Genetic Resources in Myanmar in 2018 and 2019

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Summary

Exploration and collection surveys were conducted from October 25 to November 9, 2018 and from February 10 to 26, 2019, under the collaboration between Tokyo University of Agriculture (TUA), Japan, and the Department of Agriculture Research, Myanmar. The 2018 survey was conducted at Shan State, Mandalay Region, and in a part of the Sagaing Region. In 2019, genetic resources were collected from the Eastern Shan State. Genetic resources were collected from farmlands, farmers' houses, local markets, and areas surrounding administrative offices of the Ministry of Agriculture, Livestock, and Irrigation. In all, 110 accessions, including 82 of *Brassica juncea*, 11 of *Brassica oleracea* L. *Alboglabra* Group, one of *Brassica oleracea* L. *Capitata* Group, and 16 of *Raphanus sativus* L, were collected. The collected genetic resources were divided between the Myanmar Seed Bank and TUA for the Plant Genetic Resources in Asia Project, and half of the collected resources was imported to Japan and introduced there as per the Standard Material Transfer Agreement. Imported seeds will be multiplied and evaluated in Japan and will become available from the National Agriculture and Food Research Organization Genebank, Japan, for research, breeding, and educational purposes.

KEY WORDS: *Brassica juncea*, Eastern Shan state, Myanmar, vegetable genetic resources

Introduction

Myanmar possesses a remarkable diversity of crops, owing to its diverse agroclimatic conditions and culture. Among them, *Brassica* species such as *Brassica juncea*, *B. oleracea*, *B. napus*, and *B. rapa* are widely cultivated and used in Myanmar (Ishida *et al.* 2000). We have conducted surveys and collected *Brassica* vegetable genetic resources from various parts of Myanmar under the Plant Genetic Resources in Asia (PGRAsia) Project (Wakui *et al.* 2016; Yoshida *et al.* 2017, 2018). PGRAsia is entrusted by the Ministry of Agriculture, Forestry and Fisheries (MAFF) and is jointly promoted by the Tokyo University of Agriculture (TUA) and Department of Agriculture Research (DAR), the Ministry of Agriculture, Livestock and Irrigation (MOALI) of Myanmar, which has a joint research agreement with the National Agricultural Research Organization (NARO).

During the 2015 - 2017 survey, numerous *Brassica juncea* called “Mohn Nyin,” *B. oleracea*, and *Raphanus sativus* were collected (Wakui *et al.* 2016; Yoshida *et al.* 2017, 2018). In addition, we reported that the observation of *B. juncea* with diverse morphological and physiological characteristics and varying quality traits during our survey. *B. juncea* is said to have originated in Central Asia and then diversified to India and China as secondary centers (Hemingway 1995; Singh *et al.* 2014). The genetic diversity of *B. juncea* is assumed to be conserved in Myanmar, which is located between China and India.

However, traditional varieties may have been lost because of economic and lifestyle changes in recent years. Thus, genetic resources needs to be searched and collected from unexamined areas at the earliest. In 2015, a collaborative survey was conducted to collect vegetable genetic resources, mainly from the southern part of Shan State and a part of Kayah State (Wakui *et al.* 2016); surveys were conducted in 2016 in Kachin State and Sagaing Region (Yoshida *et al.* 2017) and in 2017 in Chin State (Yoshida *et al.* 2018). Nonetheless, the surveyed areas do not cover entire Myanmar. Therefore, this year, we conducted a survey mainly in the Eastern Shan State.

Methods

Exploration and collection surveys of *Brassica* genetic resources were conducted from October 25 to November 9, 2018 (Table 1) and from February 10 to 26, 2019 (Table 2). The 2018 survey was conducted in Shan State, Mandalay Region, and a part of the Sagaing Region. The survey from October 26 to 29 was conducted on foot, and several villages were visited with guides. After October 30, we continued the survey by using a rental car with a driver. In 2019, genetic resources were collected from the Eastern Shan State.

Genetic resources were collected from farmlands, farmers' houses, local markets, and areas around the administrative offices of MOALI. We collected information such as local name, cultivation time, usage method, price, and history. In addition, we recorded the following data: the soil, terrain, surrounding environment, latitude, longitude, and altitude at the field site.

This survey was conducted under the 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 imported in Japan under the Standard Material Transfer Agreement.

Results and Discussion

In this survey, we collected a total of 110 accessions, including 82 of *Brassica juncea*, 11 of *Brassica*

Table 1. Itinerary for the collaborative exploration and collection of genetic resources in 2018

Day	Date	Route	Stay	Activities
1	25-Oct-18	Thu YEZIN - KALAW	KALAW	Exploration & Collection
2	26-Oct-18	Fri KALAW	KALAW	Exploration & Collection
3	27-Oct-18	Sat KALAW	KALAW	Exploration & Collection
4	28-Oct-18	Sun KALAW	KALAW	Exploration & Collection
5	29-Oct-18	Mon KALAW	KALAW	Exploration & Collection
6	30-Oct-18	Tue KALAW - YEZIN - YANGON	YANGON	Exploration & Collection
7	31-Oct-18	Wed YANGON	YANGON	Exploration & Collection
8	01-Nov-18	Thu YANGON - YEZIN	YEZIN	Visit to DAR
9	02-Nov-18	Fri YEZIN - MANDLAY	MANDLAY	Exploration & Collection
10	03-Nov-18	Sat MANDLAY - MAYMYO	MAYMYO	Exploration & Collection
11	04-Nov-18	Sun MAYMYO - MOGOK	YEZIN	Exploration & Collection
12	05-Nov-18	Mon MOGOK - SHEWBO	AUNGPAN	Exploration & Collection
13	06-Nov-18	Tue SHEWBO - MONYWA	AUNGPAN	Exploration & Collection
14	07-Nov-18	Wed MONYWA - BAGAN	AUNGPAN	Exploration & Collection
15	08-Nov-18	Thu BAGAN - YEZIN	YEZIN	Visit to DAR
16	09-Nov-18	Fri YEZIN - YANGON	YANGON	Transfer

DAR: Department of Agriculture Research

Table 2. Itinerary for the collaborative exploration and collection of genetic resources in 2019

Day	Date	Route	Stay	Activities
1	10-Feb-19	Sun NRT - RGN	YANGON	Transfer
2	11-Feb-19	Mon YANGON - YEZIN	YEZIN	Visit to DAR
3	12-Feb-19	Tue YEZIN	YEZIN	Visit to DAR
4	13-Feb-19	Wed YEZIN - NAMSANG	NAMSANG	Exploration & Collection
5	14-Feb-19	Thu NAMSANG - KENG TUNG	KENG TUNG	Exploration & Collection
6	15-Feb-19	Fri KENG TUNG - TACHILEKE	TACHILEKE	Exploration & Collection
7	16-Feb-19	Sat TACHILEKE	TACHILEKE	Exploration & Collection
8	17-Feb-19	Sun TACHILEKE - KENG TUNG	KENG TUNG	Exploration & Collection
9	18-Feb-19	Mon KENG TUNG	KENG TUNG	Exploration & Collection
10	19-Feb-19	Tue KENG TUNG - NAMSANG	NAMSANG	Exploration & Collection
11	20-Feb-19	Wed NAMSANG - TAUNGGYI	TAUNGGYI	Exploration & Collection
12	21-Feb-19	Thu TAUNGGYI - PINDAYA - AUNGPAN	AUNGPAN	Exploration & Collection
13	22-Feb-19	Fri AUNGPAN - YEZIN	YEZIN	Exploration & Collection
14	23-Feb-19	Sat YEZIN	YEZIN	Exploration & Collection
15	24-Feb-19	Sun YANGON	YANGON	Exploration & Collection
16	25-Feb-19	Mon YANGON	YANGON	Exploration & Collection
17	26-Feb-19	Tue RGN - NRT	-	Transfer

DAR: Department of Agriculture Research

oleracea L. *Alboglabra* Group, one of *Brassica oleracea* L. *Capitata* Group, and 16 of *Raphanus sativus* L. Most of the collected samples were native varieties. The surveyed areas included 22 townships in the Shan State, Mandalay region and Sagain region (co-ordinates: 20°30'12.18" N-21°44'46.58" N to 95°41'47.83" E-100°05'31.22" E, ranging from 300 m to 1,548 m altitude (Fig. 1).

In all regions, we noted that *Brassica* vegetables were used in fried vegetables (Photo 1) and soups (Photo 2) and in various types of pickle preparations (Photos 3 and 4). In addition, they were widely used as oil. It was sold frequently in local markets (Photos 5 and 6).

Southern Shan State, Mandalay and Sagaing Regions

Vegetable cultivation is prosperous around Kalaw Township. Although local varieties for self-consumption were cultivated in the village of the Palaun tribe (Photo 7; Y01 - Y11; Table 3), a minority ethnic group, the selection of improved varieties was also progressing, and commercial cultivation of

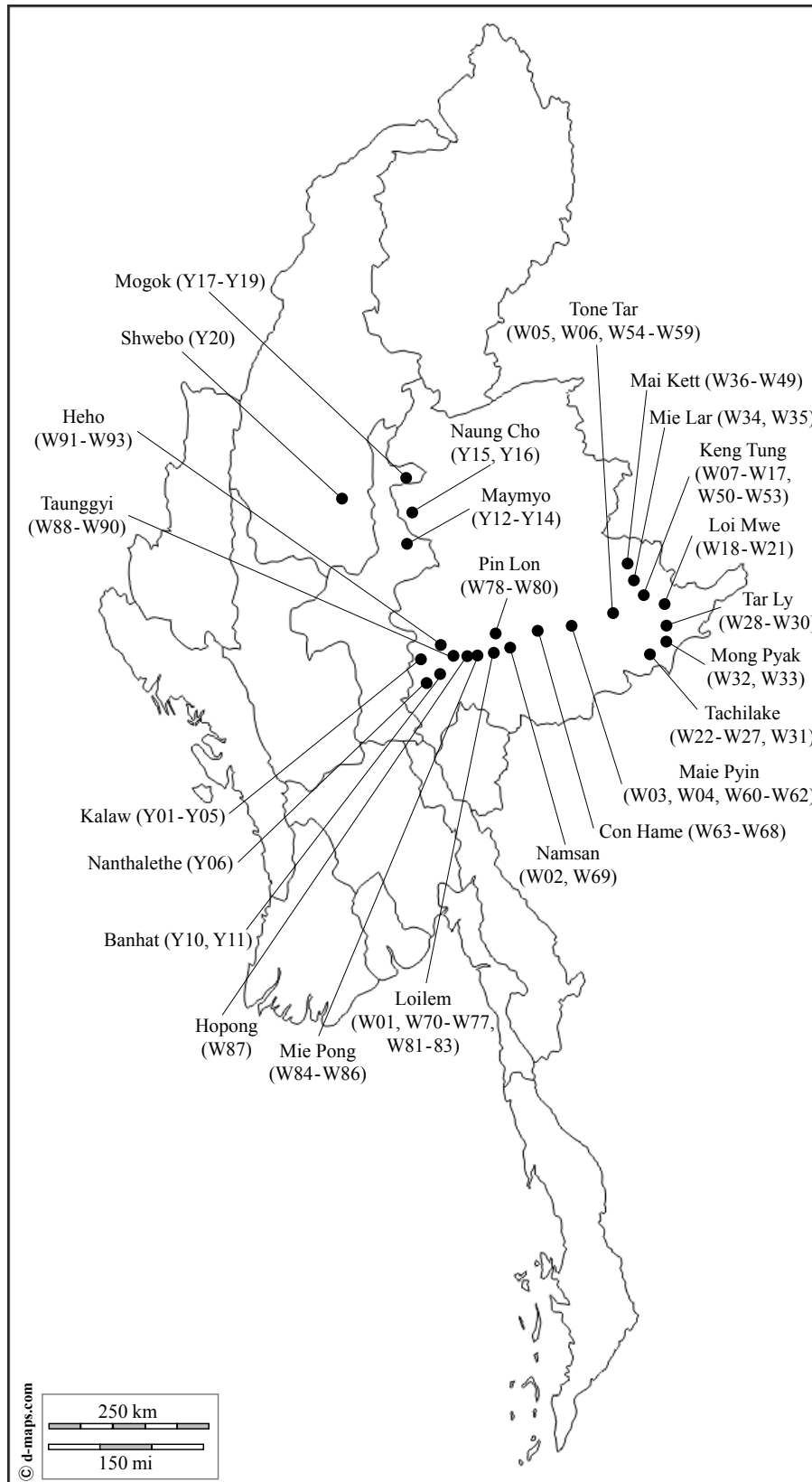


Fig. 1. Collection sites of *Brassica* in Myanmar in 2018 and 2019. The collection number of the genetic resources is included parentheses.

Taiwan varieties was considerably noted (Photo 8). In Myanmar, improved varieties from Thailand are also becoming common, but were not observed around Kalaw Township.

Many Gorkha tribes live in the area from Maymyo to Mogok (Fig. 1). In this area, oil made from *Brassica* plants called “Si Mohn Nyin” was actively used as edible oil, as well as a liniment for arthralgia and sore throat (Photo 9), especially in Naung Cho village, where the use of other oils was limited (Y15, Y16; Fig. 1, Table 3).

In Baw Lon Gyi Village in Mogok Township, which has a thriving jewelry mining industry, no large-scale vegetable farms were noted (Photo 10); however, in fields of small farmers, *Brassica* vegetables were grown, and dry vegetables were produced (Photos 11 and 12).

Eastern Shan State

Eastern Shan State is dotted with villages of ethnic minorities, such as Aka and Lahu. Each village had local varieties of *Brassica* (Photo 13). However, improved varieties from Thailand were also being cultivated. In particular, in Tachilake, which borders Thailand, very few local varieties were noted in the market (Photo 14). That is, Tachilake is in a situation similar to Myawaddy that borders Thailand in Kayin State in southern Myanmar (Yoshida *et al.* 2018). There are concerns about the loss of local varieties, but native varieties are considered to taste better than the improved varieties. This provided a glimpse of how the locals choose varieties based on their preferences. In addition, people who moved from Chin State brought perennial kailan, which is vegetatively propagated by cuttings (W31; Photo 15). It was very similar to the varieties discovered in Chin State (Yoshida *et al.* 2018). The locals in Myanmar seem to attach remarkable importance to palatability.

In Myanmar, *Brassica* as leafy vegetables can be grown year-round, but it is generally sown from September to October and cultivated until March of the following year. The farmers harvest leaves and flower stems in a timely manner during the cultivation period. Most farmers obtain their local varieties by self-seeding or local market purchases. Since February is the season of *Brassica* seed production, many farmers were found to produce seed (Photos 16 and 17).

Edible root radish is cultivated in Loilem Township (Photo 18) and is processed into pickles. White and purple flowered radishes were mixed and cultivated in the field (Photo 19), but no difference in the cultivation method or utilization was noted depending on the flower color. Some varieties of radish may be useful for breeding because their seedpods were brittle and have high threshing properties (W70-W75). Large-scale radish cultivation was observed around the Heho Township, in particular in the north road from Heho. The collected radishes are not edible, but are used only as oil crops (W91, W92; Photo 20).

Large quantities of the oil plant “Si Mohn Nyin” were cultivated in large-scale commercial fields in Eastern Shan State (Photo 21). Seeds were collected from some plants after the leaves were used as fresh vegetables for approximately six months after sowing. Oil production for Si Mohn Nyin was increased by selecting cultivars with huge seeds. Ishida *et al.* (2000) reported that Si Mohn Nyin (Se Mohn Nyin) is *B. rapa* or *B. napus*. However, as inferred from morphological traits, Si Mohn Nyin includes *B. oleracea* and *B. juncea*, as well as *B. rapa* and *B. napus*.

Myanmar government reported that they cultivate *B. napus*, *B. rapa*, *B. nigra*, and *B. juncea*, but general farmers recognize it as a kind of “Mohn Nyin”; hence, it was not named properly. As reported by Ishida *et al.* (2000) and Wakui *et al.* (2016), it was occasionally referred to by local names based on morphological traits or uses (Shi Mohn Nyin, oil mustard; Mohn Nyin Phyu, white mustard; Mohn Nyin

Sein, green mustard), but it was not consistent (Photo 22). Because of the unclear classification and farmers perform self-seeding, several kinds of Brassicaceae were cultivated in a miscellaneous fashion in one field (Photo 23).

To date, vegetables called “Mohn Nyin” were assumed to be *B. juncea*. However, from our results, “Mohn Nyin” in Myanmar might contain several *Brassica* species such as *B. rapa* and *B. napus* in addition to *B. juncea*. We also concluded that Myanmar is rich in not only *B. juncea* but also other *Brassica* genetic resources. Therefore, the actual situation regarding the diversity of Brassicaceae genetic resources in Myanmar needs to be clarified, to select promising lines and collect more genetic resources.

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ミャンマーにおけるアブラナ属野菜類遺伝資源の 共同探索・収集，2018年および2019年

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和文摘要

ミャンマー連邦共和国において，“Mohn Nyin”と呼ばれる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を行った。2018年10月25日から11月9日までシャン州カロー周辺，マンドレー管区およびザガイン管区の一部で収集を行った。また，2019年2月10日から26日は東部シャン州において収集を行った。その結果，*Brassica juncea* 82点，*B. oleracea* L. *Alboglabra* Group 11点，*B. oleracea* L. *Capitata* Group 1点，*Raphanus sativus* L. 16点の計110点が収集された。調査はミャンマー農業畜産灌漑省農業研究局および東京農業大学の共同で行われた。収集品は2分し，一方はミャンマーシードバンクで，他方はSMTAに基づき日本に導入された後，農業研究，育種，教育目的で配布可能な遺伝資源として，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。

Table 3. A list of plant materials collected in 2018 and 2019

Coll. No.	JP No.	Species	Local name	Date of collection	Collection sites	Town Ship	Name of village/market	Latitude	Longitude	Altitude (m)	Collection source	Usage
Y01	270094	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2018/10/25	Shan state	Kalaw	-	N20 34'56.54"	E96 30'49.27"	1,407	Farmer	leaf vegetable
Y02	270095	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2018/10/25	Shan state	Kalaw	-	N20 34'56.54"	E96 30'49.27"	1,407	Farmer	leaf vegetable
Y03	270096	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2018/10/25	Shan state	Kalaw	-	N20 34'00.58"	E96 33'14.02"	1,320	Farmer	leaf vegetable
Y04	270097	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2018/10/26	Shan state	Kalaw	-	N20 33'58.89"	E96 34'19.16"	1,300	Farmer	leaf vegetable
Y05	270098	<i>Raphanus sativus</i> L.	Mon lan U	2018/10/26	Shan state	Kalaw	-	N20 33'58.89"	E96 34'19.16"	1,300	Farmer	leaf vegetable
Y06	270099	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2018/10/27	Shan state	Nanthalethe	Tha yat pin Village	N20 30'12.18"	E96 37'11.48"	1,273	Farmer	leaf vegetable
Y10	270100	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2018/10/27	Shan state	Banhat	Pattu Paok Village	N20 31'41.60"	E96 43'20.40"	1,327	Farmer	leaf vegetable
Y11	270101	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2018/10/28	Shan state	Banhat	Pattu Paok Village	N20 31'41.60"	E96 43'20.40"	1,327	Farmer	leaf vegetable
Y12	270102	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2018/11/4	Shan state	Maymyo	Maymyo market	N22 10'52.55"	E96 28'34.01"	1,222	Market	leaf vegetable
Y13	270103	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2018/11/4	Shan state	Maymyo	Maymyo market	N22 10'52.55"	E96 28'34.01"	1,222	Market	leaf vegetable
Y14	270104	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2018/11/4	Shan state	Maymyo	Maymyo market	N22 10'52.55"	E96 28'34.01"	1,222	Market	leaf vegetable
Y15	270105	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2018/11/4	Shan state	Naung cho	Thaung Soe Village	N22 17'06.26"	E96 37'23.41"	754	Farmer	oil
Y16	270106	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2018/11/4	Shan state	Naung cho	Kone San Village	N22 29'43.04"	E96 29'23.48"	994	Farmer	oil
Y17	270107	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2018/11/4	Mandalay region	Mogok	Mogok	N22 55'16.85"	E96 29'58.13"	1,116	Farmer	leaf vegetable
Y18	270108	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2018/11/5	Mandalay region	Mogok	Baw Lon Gyi	N22 55'03.81"	E96 23'59.11"	1,410	Farmer	leaf vegetable
Y19	270109	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2018/11/5	Mandalay region	Mogok	Sein Kone Village	N22 54'42.67"	E96 26'54.13"	1,365	Farmer	leaf vegetable
Y20	270110	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2018/11/6	Sagaing region	Shwebo	SiPinTaYar market	N22 33'47.92"	E95 41'47.83"	990	Market	leaf vegetable
W01	270125	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/13	Shan State	Loilem	Mala village	N20 53'00.34"	E97 32'39.74"	1,300	Farmer	leaf vegetable
W02	270126	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/13	Shan State	Namsan	Mee Tway Kone Village	N20 54'33.93"	E97 41'40.08"	1,006	Farmer	leaf vegetable
W03	270127	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/14	Shan State	Maie Pyin	Pam Khain village	N21 20'33.86"	E98 55'32.11"	1,198	Farmer	leaf vegetable
W04	270128	<i>Raphanus sativus</i> L.	Mon lan U	2019/2/14	Shan State	Maie Pyin	Pam Khain village	N21 20'33.86"	E98 55'32.11"	1,198	Farmer	fruit vegetable
W05	270129	<i>Brassica juncea</i> L. Czern.	Bo kyar yaw Mon Nyin	2019/2/14	Shan State	Toung Tar	Shwe Nieung village	N21 17'36.40"	E99 20'12.85"	1,170	Farmer	leaf vegetable
W06	270130	<i>Raphanus sativus</i> L.	Mon lan U	2019/2/14	Shan State	Toung Tar	Shwe Nieung village	N21 17'36.40"	E99 20'12.85"	1,170	Farmer	leaf vegetable
W07	270131	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/15	Shan State	Keng Tung	Keng Tung market	N21 17'10.11"	E99 36'10.17"	680	Market	leaf vegetable
W06	270132	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/15	Shan State	Keng Tung	Keng Tung market	N21 17'10.11"	E99 36'10.17"	680	Market	leaf vegetable
W07	270133	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/15	Shan State	Keng Tung	Keng Tung market	N21 17'10.11"	E99 36'10.17"	680	Market	leaf vegetable
W10	270134	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/15	Shan State	Keng Tung	Keng Tung market	N21 17'10.11"	E99 36'10.17"	680	Market	leaf vegetable
W11	270135	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/15	Shan State	Keng Tung	Keng Tung market	N21 17'10.11"	E99 36'10.17"	680	Market	leaf vegetable
W12	270136	<i>Raphanus sativus</i> L.	Mon lan U	2019/2/15	Shan State	Keng Tung	Wun Cha village	N21 15'37.26"	E99 38'27.85"	700	Farmer	fruit vegetable
W13	270137	<i>Raphanus sativus</i> L.	Mon lan U	2019/2/15	Shan State	Keng Tung	Wun Cha village	N21 15'37.26"	E99 38'27.85"	700	Farmer	fruit vegetable
W14	270138	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/15	Shan State	Keng Tung	Wun Cha village	N21 15'37.26"	E99 38'27.85"	700	Farmer	leaf vegetable
W15	270139	<i>Brassica oleracea</i> L. <i>Alboglabra</i>	Kailan	2019/2/15	Shan State	Keng Tung	Wun Kaen village	N21 14'45.54"	E99 41'22.03"	742	Farmer	leaf vegetable
W16	270140	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/15	Shan State	Keng Tung	Wun Kaen village	N21 14'45.54"	E99 41'22.03"	742	Farmer	leaf vegetable
W17	270141	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/15	Shan State	Keng Tung	Wun Kaen village	N21 14'45.54"	E99 41'22.03"	742	Farmer	leaf vegetable
W18	270142	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/15	Shan State	Loi Mwe	Ywa Thit village	N21 10'31.08"	E99 45'38.38"	1,548	Farmer	leaf vegetable
W19	270143	<i>Raphanus sativus</i> L.	Mon lan U	2019/2/15	Shan State	Loi Mwe	Ywa Thit village	N21 20'30.43"	E99 45'58.20"	1,544	Farmer	fruit vegetable
W20	270144	<i>Raphanus sativus</i> L.	Mon lan U	2019/2/15	Shan State	Loi Mwe	Ywa Thit village	N21 20'30.43"	E99 45'58.20"	1,544	Farmer	fruit vegetable
W21	270145	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/15	Shan State	Loi Mwe	Ywa Thit village	N21 20'30.43"	E99 45'58.20"	1,544	Farmer	leaf vegetable
W22	270146	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/16	Shan State	Tachilake	Won Cown market	N20 26'59.83"	E99 52'54.83"	300	Market	leaf vegetable
W23	270147	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/16	Shan State	Tachilake	Man Late Par Kaw village	N20 31'06.54"	E99 59'34.03"	319	Farmer	leaf vegetable
W24	270148	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/16	Shan State	Tachilake	Man Late Par Kaw village	N20 31'02.61"	E99 59'29.62"	310	Farmer	leaf vegetable
W25	270149	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/16	Shan State	Tachilake	Si Naw village	N20 34'04.53"	E99 59'16.85"	340	Farmer	leaf vegetable

Table 3. (Continued).

Coll. No.	JP No.	Species	Local name	Date of collection	Collection sites	Town Ship	Name of village/market	Latitude	Longitude	Altitude (m)	Collection source	Usage
W26	270150	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/16	Shan State	Tachilake	Toung Tonp Lone village	N20 37'31.95"	E100 02'36.38"	484	Farmer	leaf vegetable
W27	270151	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/16	Shan State	Tachilake	Hway Khait village	N20 40'04.24"	E100 05'31.22"	373	Farmer	leaf vegetable
W28	270152	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/16	Shan State	Tar Ly	Tar Ly	N20 43'34.74"	E100 03'24.36"	370	Farmer	leaf vegetable
W29	270153	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/16	Shan State	Tar Ly	Tar Ly	N20 43'34.74"	E100 03'24.36"	370	Farmer	leaf vegetable
W30	270154	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/16	Shan State	Tar Ly	Tar Ly	N20 42'33.25"	E100 05'10.65"	377	Farmer	leaf vegetable
W31	270155	<i>Brassica oleracea</i> L. <i>Capitata</i>	Ann Nu	2019/2/17	Shan State	Tachilake	Toung Tonp Lone village	N20 37'31.95"	E100 02'36.38"	484	Farmer	leaf vegetable
W32	270156	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/17	Shan State	Mong Pyak	Phat Kar Yeck village	N20 52'37.36"	E99 55'42.96"	423	Farmer	leaf vegetable
W33	270157	<i>Brassica oleracea</i> L. <i>Alboglabra</i>	Kailan	2019/2/17	Shan State	Mong Pyak	Phat Hone village	N20 54'55.40"	E99 58'31.92"	473	Farmer	leaf vegetable
W34	270158	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/18	Shan State	Mie Lar	Wan Tar Pon village	N21 34'10.91"	E99 31'02.14"	698	Farmer	leaf vegetable
W35	270159	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/18	Shan State	Mie Lar	Wan Tar Pon village	N21 34'10.91"	E99 31'02.14"	698	Farmer	leaf vegetable
W36	270160	<i>Brassica oleracea</i> L. <i>Alboglabra</i>	Kailan	2019/2/18	Shan State	Mai Kett	Sut Pa Long village	N21 44'43.77"	E99 27'05.83"	739	Farmer	leaf vegetable
W37	270161	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/18	Shan State	Mai Kett	Sut Pa Long village	N21 44'43.77"	E99 27'05.83"	739	Farmer	leaf vegetable
W38	270162	<i>Brassica oleracea</i> L. <i>Alboglabra</i>	Si Mohn Nyin	2019/2/18	Shan State	Mai Kett	Sut Pa Long village	N21 44'43.77"	E99 27'05.83"	739	Farmer	oil
W39	270163	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/18	Shan State	Mai Kett	Yam Taung vllage	N21 44'46.58"	E99 26'59.88"	747	Farmer	leaf vegetable
W40	270164	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/18	Shan State	Mai Kett	Yam Taung vllage	N21 44'46.58"	E99 26'59.88"	747	Farmer	leaf vegetable
W41	270165	<i>Brassica juncea</i> L. Czern.	Si Mohn Nyin	2019/2/18	Shan State	Mai Kett	Yam Taung vllage	N21 44'46.58"	E99 26'59.88"	747	Farmer	oil
W42	270166	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/18	Shan State	Mai Kett	Yam Taung vllage	N21 44'46.58"	E99 26'59.88"	747	Farmer	leaf vegetable
W43	270167	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/18	Shan State	Mai Kett	Yat Kwat village	N21 44'46.43"	E99 27'35.81"	748	Farmer	leaf vegetable
W44	270168	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/18	Shan State	Mai Kett	Nant Tar Pin village	N21 44'20.87"	E99 28'56.09"	762	Farmer	leaf vegetable
W45	270169	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/18	Shan State	Mai Kett	Taung Thone village	N21 42'04.15"	E99 28'21.86"	776	Farmer	leaf vegetable
W46	270170	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/18	Shan State	Mai Kett	Taung Thone village	N21 42'04.15"	E99 28'21.86"	776	Farmer	leaf vegetable
W47	270171	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/18	Shan State	Mai Kett	Taung Thone village	N21 42'04.15"	E99 28'21.86"	776	Farmer	leaf vegetable
W48	270172	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/18	Shan State	Mai Kett	Taung Thone village	N21 42'04.15"	E99 28'21.86"	776	Farmer	leaf vegetable
W49	270173	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/18	Shan State	Mai Kett	Taung Thone village	N21 42'04.15"	E99 28'21.86"	776	Farmer	leaf vegetable
W50	270174	<i>Brassica juncea</i> L. Czern.	Par Mohn Nyin	2019/2/19	Shan State	Keng Tung	Tung Chaly village	N21 18'06.71"	E99 21'10.41"	975	Farmer	leaf vegetable
W51	270175	<i>Brassica juncea</i> L. Czern.	Par Mohn Nyin	2019/2/19	Shan State	Keng Tung	Tung Chaly village	N21 18'06.71"	E99 21'10.41"	975	Farmer	leaf vegetable
W52	270176	<i>Brassica juncea</i> L. Czern.	Par Mohn Nyin	2019/2/19	Shan State	Keng Tung	Tung Chaly village	N21 18'06.71"	E99 21'10.41"	975	Farmer	leaf vegetable
W53	270177	<i>Brassica juncea</i> L. Czern.	Par Mohn Nyin	2019/2/19	Shan State	Keng Tung	Tung Chaly village	N21 18'06.71"	E99 21'10.41"	975	Farmer	leaf vegetable
W54	270178	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/19	Shan State	Toung Tar	-	N21 20'08.30"	E99 16'36.97"	672	Farmer	leaf vegetable
W55	270179	<i>Brassica oleracea</i> L. <i>Alboglabra</i>	Kailan	2019/2/19	Shan State	Toung Tar	-	N21 20'08.30"	E99 16'36.97"	672	Farmer	leaf vegetable
W56	270180	<i>Raphanus sativus</i> L.	Mon lan U	2019/2/19	Shan State	Toung Tar	-	N21 20'08.30"	E99 16'36.97"	672	Farmer	vegetable
W57	270181	<i>Brassica juncea</i> L. Czern.	Si Mohn Nyin	2019/2/19	Shan State	Toung Tar	Tung Yone Lone	N21 21'36.71"	E99 12'01.11"	850	Farmer	oil, leaf eat
W58	270182	<i>Brassica juncea</i> L. Czern.	Si Mohn Nyin	2019/2/19	Shan State	Toung Tar	Tung Yone Lone	N21 21'36.71"	E99 12'01.11"	850	Farmer	oil, leaf eat
W59	270183	<i>Brassica juncea</i> L. Czern.	Si Mohn Nyin	2019/2/19	Shan State	Toung Tar	Tung Yone Lone	N21 21'36.71"	E99 12'01.11"	850	Farmer	oil, leaf eat
W60	270184	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/19	Shan State	Maie Pyin	Sine Moug village	N21 20'55.50"	E99 49'07.66"	505	Farmer	leaf vegetable
W61	270185	<i>Brassica oleracea</i> L. <i>Alboglabra</i>	Kailan	2019/2/19	Shan State	Maie Pyin	Sine Moug village	N21 20'55.50"	E99 49'07.66"	505	Farmer	leaf vegetable
W62	270186	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/19	Shan State	Maie Pyin	Sine Moug village	N21 20'55.50"	E99 49'07.66"	505	Farmer	leaf vegetable
W63	270187	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/19	Shan State	Con Hame	Phein Phyan village	N21 16'37.35"	E98 29'10.02"	549	Farmer	leaf vegetable
W64	270188	<i>Brassica juncea</i> L. Czern.	Si Mohn Nyin	2019/2/19	Shan State	Con Hame	Phein Phyan village	N21 16'33.95"	E98 28'33.16"	537	Farmer	oil
W65	270189	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/19	Shan State	Con Hame	Compound village	N21 14'11.01"	E98 14'20.45"	834	Farmer	leaf vegetable
W66	270190	<i>Brassica oleracea</i> L. <i>Alboglabra</i>	Si Mohn Nyin	2019/2/19	Shan State	Con Hame	Compound village	N21 14'11.01"	E98 14'20.45"	834	Farmer	leaf vegetable
W67	270191	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/19	Shan State	Con Hame	Compound village	N21 14'11.01"	E98 14'20.45"	834	Farmer	leaf vegetable

Table 3. (Continued).

Coll. No.	JP No.	Species	Local name	Date of collection	Collection sites	Town Ship	Name of village/market	Latitude	Longitude	Altitude (m)	Collection source	Usage
W68	270192	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/19	Shan State	Con Hame	Compound village	N21 14'11.01"	E98 14'20.45"	834	Farmer	leaf vegetable
W69	270193	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/20	Shan State	Namsang	Namsang	N20 53'48.23"	E97 42'26.70"	852	Farmer	leaf vegetable
W70	270194	<i>Raphanus sativus</i> L.	Mon Lan U	2019/2/20	Shan State	Loilem	-	N20 56'39.84"	E97 32'12.93"	1,199	Farmer	vegetable
W71	270195	<i>Raphanus sativus</i> L.	Mon Lan U	2019/2/20	Shan State	Loilem	-	N20 56'39.84"	E97 32'12.93"	1,199	Farmer	vegetable
W72	270196	<i>Raphanus sativus</i> L.	Mon Lan U	2019/2/20	Shan State	Loilem	-	N20 56'39.84"	E97 32'12.93"	1,199	Farmer	vegetable
W73	270197	<i>Raphanus sativus</i> L.	Mon Lan U	2019/2/20	Shan State	Loilem	-	N20 56'39.84"	E97 32'12.93"	1,199	Farmer	vegetable
W74	270198	<i>Raphanus sativus</i> L.	Mon Lan U	2019/2/20	Shan State	Loilem	-	N20 56'39.84"	E97 32'12.93"	1,199	Farmer	vegetable
W75	270199	<i>Raphanus sativus</i> L.	Mon Lan U	2019/2/20	Shan State	Loilem	-	N20 56'39.84"	E97 32'12.93"	1,199	Farmer	vegetable
W76	270200	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/20	Shan State	Loilem	-	N20 56'39.84"	E97 32'12.93"	1,199	Farmer	leaf vegetable
W77	270201	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/20	Shan State	Loilem	-	N20 56'39.84"	E97 32'12.93"	1,199	Farmer	leaf vegetable
W78	270202	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/20	Shan State	Pin Lon	Wam Amm village	N20 57'55.91"	E97 31'39.54"	1,211	Market	leaf vegetable
W79	270203	<i>Brassica oleracea</i> L. <i>Alboglabra</i>	Kailan	2019/2/20	Shan State	Pin Lon	Wam Amm village	N20 57'55.91"	E97 31'39.54"	1,211	Farmer	oil, leaf eat
W80	270204	<i>Brassica oleracea</i> L. <i>Alboglabra</i>	Kailan	2019/2/20	Shan State	Pin Lon	Wam Amm village	N20 57'55.91"	E97 31'39.54"	1,211	Farmer	oil, leaf eat
W81	270205	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/20	Shan State	Loilem	Loilem market	N20 55'20.42"	E97 33'46.68"	1,212	Farmer	leaf vegetable
W82	270206	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/20	Shan State	Loilem	Loilem market	N20 55'20.42"	E97 33'46.68"	1,212	Farmer	leaf vegetable
W83	270207	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/20	Shan State	Loilem	Cho Kham village	N20 51'56.54"	E97 28'32.83"	1,029	Farmer	leaf vegetable
W84	270208	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/20	Shan State	Mie Pong	Pin Hell village	N20 51'56.40"	E97 28'56.40"	1,176	Farmer	leaf vegetable
W85	270209	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/20	Shan State	Mie Pong	Pin Hell village	N20 51'56.40"	E97 28'56.40"	1,176	Farmer	leaf vegetable
W86	270210	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/20	Shan State	Mie Pong	Pin Hell village	N20 51'56.40"	E97 28'56.40"	1,176	Farmer	leaf vegetable
W87	270211	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/20	Shan State	Hopong	Lawa Hole Toke village	N20 49'42.82"	E97 21'26.08"	1,132	Farmer	leaf vegetable
W88	270212	<i>Brassica oleracea</i> L. <i>Alboglabra</i>	Kailan	2019/2/21	Shan State	Taunggyi	Phayar Phyu	N20 48'18.60"	E97 03'43.20"	1,320	Farmer	leaf vegetable
W89	270213	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/21	Shan State	Taunggyi	Phayar Phyu	N20 48'09.57"	E97 03'32.97"	1,328	Farmer	leaf vegetable
W90	270214	<i>Brassica oleracea</i> L. <i>Alboglabra</i>	Kailan	2019/2/21	Shan State	Taunggyi	Phayar Phyu	N20 48'09.57"	E97 03'32.97"	1,328	Farmer	leaf vegetable
W91	270215	<i>Raphanus sativus</i> L.	Mon lan U	2019/2/21	Shan State	Heho	Ley Khun Tik village	N20 49'52.25"	E96 45'54.01"	1,169	Farmer	oil
W92	270216	<i>Raphanus sativus</i> L.	Mon lan U	2019/2/21	Shan State	Heho	Ley Khun Tik village	N20 49'52.25"	E96 45'54.01"	1,169	Farmer	oil
W93	270217	<i>Brassica juncea</i> L. Czern.	Mohn Nyin	2019/2/21	Shan State	Heho	Ley Khun Tik village	N20 49'52.25"	E96 45'54.01"	1,169	Farmer	leaf vegetable



Photo 1. Stir-fried vegetables with Mohn Nyin.



Photo 2. Vegetables soup with Mohn Nyin.



Photo 3. Pickles of Mohn Nyin.



Photo 4. Pickles of Mohn Nyin's flower stem.



Photo 5. Mohn Nyin sold at the Maymyo market in Myanmar.



Photo 6. Pickles of Mohn Nyin sold at the Maymyo market.



Photo 7. Local varieties of *Brassica* plants growing in a commercial field, Kalaw Township.

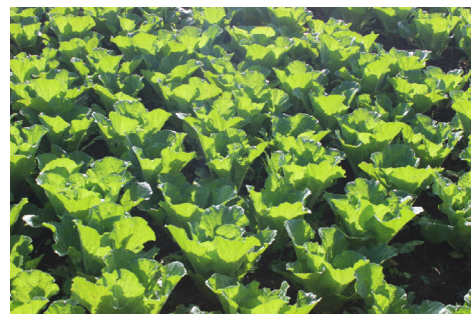


Photo 8. Taiwan varieties of *Brassica juncea* growing in a commercial field, Kalaw Township.



Photo 9. Mohn Nyin oil sold at local shop, Naung cho Township.



Photo 10. Mohn Nyin field and jewelry quarry, Baw Lon Gyi Village, Mogok Township.



Photo 11. Drying Mohn Nyin, Baw Lon Gyi Village, Mogok Township.



Photo 12. Pretreatment of Mohn Nyin for processing, Baw Lon Gyi Village, Mogok Township.



Photo 13. A farmer harvesting *B. juncea* in the field.



Photo 14. Seed shop with many improved varieties, Tachilake Township.



Photo 15. Perennial cabbage (*B. oleracea*), Tachilake Township.



Photo 16. Seed production field, Taunggyi Township.



Photo 17. Harvested *Brassica* seeds.



Photo 18. Radish (*Raphanus sativus*) produced for edible roots and fruits.



Photo 19. White and purple flowered radishes observed in the field, Loilem Township.



Photo 20. *Raphanus sativus* for oil waiting for harvest, Heho Township.



Photo 21. Large "Si Mohn Nyin" field.



Photo 22. "Mohn Nyin Phyu," white mustard; "Mohn Nyin Sein," green mustard sold in Yezin market.



Photo 23. Several *Brassica* vegetables grown in the same field.