

Exploration and Collection of Vegetable Genetic Resources within Brassicaceae in and around Kachin State of Myanmar

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Summary

This exploration and collection survey was carried out from August 21 to September 6, 2016, under collaboration between Tokyo University of Agriculture (TUA) and the Department of Agriculture Research (DAR). The surveyed areas are six townships of Kachin State, four townships of Sagaing State, and three other townships. Genetic resources were collected from farmlands, farm houses, local markets, and the areas around the administrative offices of the Ministry of Agriculture and Irrigation (MOAI). In all, 101 samples were collected, including 80 of *Brassica juncea* L., seven of *B. oleracea* L., one of *Lactuca sativa* L., and 13 of *Raphanus sativus* L. Collected genetic resources were divided between the Myanmar Seed Bank and TUA for the PGRAsia Project, while half of them were introduced to Japan as per the Standard Material Transfer Agreement (SMTA).

KEY WORDS: Myanmar, Kachin state, Vegetable genetic resources, *Brassica juncea*

Introduction

Myanmar is located in Southeast Asia. The country borders with Bangladesh, India, Thailand, Laos, and China. The longest river in the Myanmar is the Ayeyarwady River, which flows across the country in a north to south direction. Soil from the Ayeyarwady riverbed collects in the Irrawaddy delta, producing fertile land in the process. Although Myanmar is almost completely covered by tropical habitats, a wide range of climatic conditions exists based on terrain. Annual rainfall ranges from 800 mm to 5,000 mm. There are two weather seasons; the rainy season from May to October, followed by the dry season, from

October to May. Further, Myanmar is a multiethnic country with a vast cultural diversity. Reports on collection of genetic resources are scarce, while the country has extensive genetic resources of crops and vegetables that vary with climate and culture.

In 2014, the NIAS (National Institute of Agricultural Resources, currently the National Agriculture and Food Research Organization) Genetic Resources Center began a five-year plan, called the “Collaborative Research Project on Characterization and Evaluation of Plant Genetic Resources for Food and Agriculture” to promote surveying, characterization, and evaluation of plant genetic resources in some Asian countries (PGRAsia). PGRAsia is entrusted by the Ministry of Agriculture, Forestry and Fisheries (MAFF) of the Government of Japan. Japan and the NIAS organized a joint research group with the public agricultural research institutes and universities to implement this project. NIAS, the Department of Agriculture Research (DAR) and the Ministry of Agriculture and Irrigation (MOAI) of Myanmar, have recognized that the MAFF project is in line with the objective of the Memorandum of Understanding (MOU) between DAR and NIAS, signed on June 16, 2014. NIAS has concluded a joint research contract with Tokyo University of Agriculture (TUA) for the PGRAsia Project (Wakui *et al.* 2016).

According to a survey in this country, Brassicaceae, especially *Brassica juncea* L., are widely cultivated and used in Myanmar (Ishida *et al.* 2000). A collaborative survey and collection of Brassicaceae genetic resource in and around the southern Shan State of Myanmar in 2015 reported that local varieties of *B. juncea* were used as a commodity for residents. Regarding earlier studies, *B. juncea* was found to be cultivated and used across the country. This survey, conducted in 2016, reports the exploration and collection of Brassicaceae vegetable genetic resources, especially *B. juncea*, in areas around the northern part of Kachin State in Myanmar.

Methods

The main exploration and collection survey was carried out from August 21 to September 6, 2016 and a sub-survey was conducted from August 13 to 20. Selected areas for the study were six townships in Kachin State, four townships in Sagaing State, two townships in Mon State and one township in Kayah State (Fig. 1). Genetic resources were collected from farmlands, farm houses, local markets, and the area around administrative offices of the Ministry of Agriculture and Irrigation (MOAI). In markets and fields, information was collected, including name, cultivation time, usage, price, and history. Also, we recorded the morphology, the surrounding environment, and location (latitude, longitude and altitude) on the field.

This survey was conducted under Prior Informed Consent (PIC) between the Seed Bank of MOAI of Myanmar and TUA for the PGRAsia Project. Collected genetic resources were divided equally between the Myanmar Seed Bank and TUA for the PGRAsia Project, and half of them were introduced to Japan under the Standard Material Transfer Agreement (SMTA).

Results

Surveyed areas are six townships of Kachin State, four townships of Sagaing State, and three more townships, all ranging from 16°15'25"N to 27°24'25"N, and from 97°21'04"E to 98°29'57"E; and from 34 m to 490 m in altitude (Fig. 1). The total number of samples collected was 101, including 80 of *B. juncea*, seven of *B. oleracea* L., one of *Lactuca sativa* L., and 13 of *Raphanus sativus* L. (Table 2).

Table 1. Itinerary for collaborative exploration and collection of genetic resources in Kachin State in 2016

Days	Date	Route	Stay	Activities
1	21-Aug-16	Depart from Narita (NH813 NRT 1100 - RGN 1540)	Yangon	Transfer
2	22-Aug-16	YANGON – YEZIN	Yesin	Visit to DAR
3	23-Aug-16	YEZIN – SHWEBO	Shwebo	Exploration & Collection
4	24-Aug-16	SHWEBO – MYITKYINA	Myitkyina	Exploration & Collection
5	25-Aug-16	MYITKYINA	Myitkyina	Exploration & Collection
6	26-Aug-16	MYITKYINA – PUTAO	Putao	Exploration & Collection
7	27-Aug-16	PUTAO	Putao	Exploration & Collection
8	28-Aug-16	PUTAO – MYITKYINA	Myitkyina	Exploration & Collection
9	29-Aug-16	MYITKYINA – KATHA	Katha	Exploration & Collection
10	30-Aug-16	KATHA	Katha	Exploration & Collection
11	31-Aug-16	KATHA – MONYWA	Monywa	Exploration & Collection
12	1-Sep-16	MONYWA - NYAUNG U	Nyaung U	Exploration & Collection
13	2-Sep-16	NYAUNG U – YEZIN	Yesin	Exploration & Collection
14	3-Sep-16	YEZIN	Yesin	Seed cleaning & Preparation of SMTA
15	4-Sep-16	YEZIN – YANGON	Yangon	Transfer
16	5-Sep-16	NH814 RGN 2210 -	On a Plane	Transfer
17	6-Sep-16	Arrive Narita (- NRT 0645)		

DAR: Department of Agriculture Research

SMTA: The Standard Material Transfer Agreement

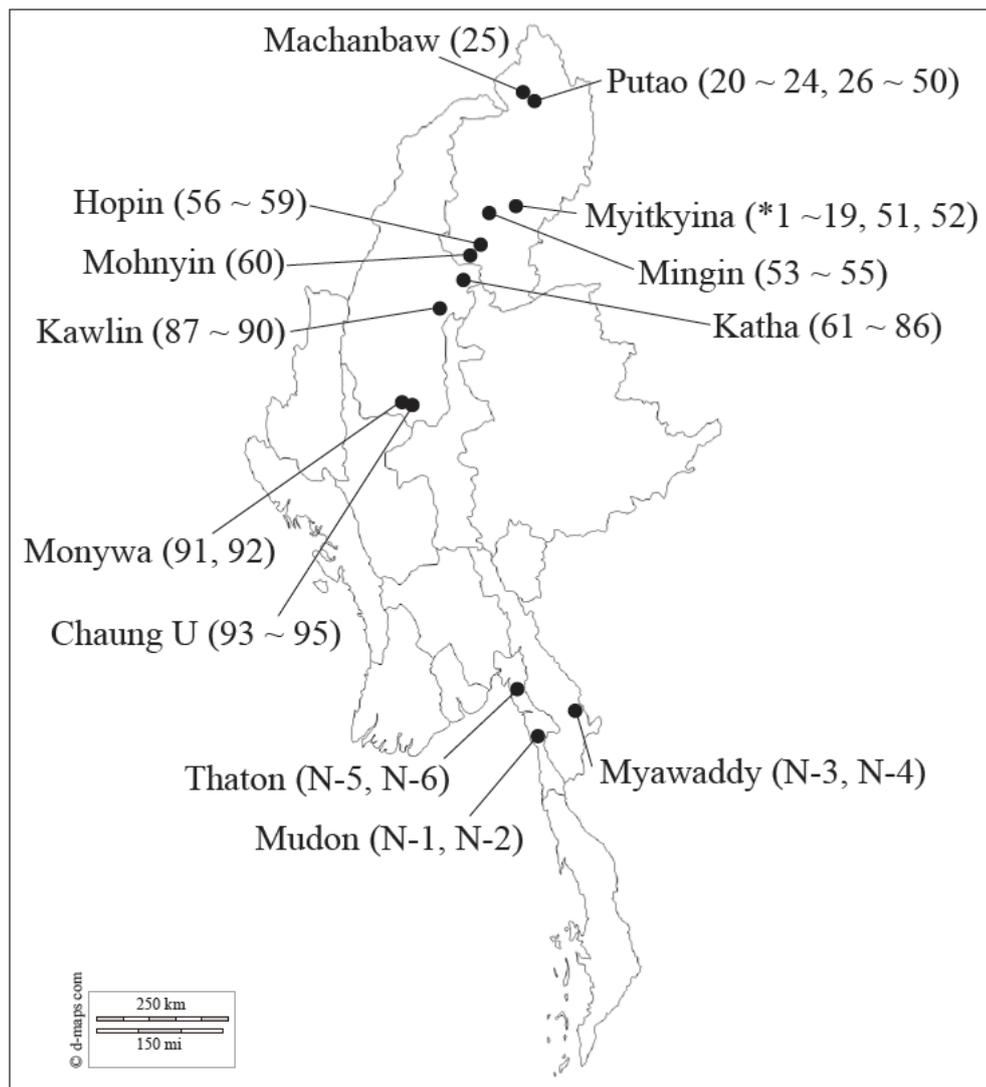


Fig. 1 Collection sites of Brassicaceae in Myanmar

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

Table 2. A summary of collections by township

Plants	Collection Sites													Total
	Kachin State						Sagaing State				Mon State		Kayin State	
	Hopin	Mohnyin	Myitkyin	Putao	Machanbaw	Mingin	Kawlin	Katha	Monywa	Chaung U	Mudon	Thaton	Myawaddy	
<i>Brassica juncea</i>	4	1	15	23	1	3	3	20	1	3	2	2	2	80
<i>Brassica oleracea</i>	0	0	1	0	0	0	0	5	1	0	0	0	0	7
<i>Raphanus sativus</i>	0	0	4	7	0	0	1	1	0	0	0	0	0	13
<i>Lactuca sativa</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Total	4	1	21	30	1	3	4	26	2	3	2	2	2	101

Mustard (*Brassica juncea* L.)

B. juncea is used as a vegetable and oil crop in each region of Myanmar. It is cooked as a vegetable addition to soup (Photograph 1) and curry. This vegetable can be used at different growth stages; thus, the duration of its growth in the field varies from several weeks to several months after sowing. The fresh vegetables are sold at the market (Photographs 2 - 4). Also, *B. juncea* is processed into pickles and is sold at the market (Photographs 5 and 6).

Most of the collected samples are native varieties. *B. juncea* is usually cultivated in table gardens for domestic consumption (Photograph 7), but sometimes it is cultivated in commercial farmland (Photographs 8 and 9). *B. juncea* can grow all year round. In this region, *B. juncea* is usually sown from September to November, and growth takes 4 months. Therefore, we only saw plants at the seedling stage (Photographs 10 and 11). Seedlings of some varieties are shipped about 20 days to one month after sowing (No. 81), and the variety with shortest growth duration until shipment was seen in the Katha region. We confirmed that one variety is harvested with unripe fruit and used for salads (No. 90).

Most farmers obtain seeds from their own plants. Seed retail shops have usually dealt with the native variety of *B. juncea* (Photograph 12), while commercial varieties have been introduced from China recently. The seeds are stored into bottles or other containers (Photograph 13). People of the Lisu tribe, who live in Putao, the northernmost town in Myanmar, put seeds into gourd bottles and keep them above their hearths for fumigating (Photograph 14).

The 15 varieties of seeds used for oil were collected. Those seeds were ground using a water wheel (Photographs 15 and 16). The plant residues were used as domestic animal feed (Photographs 17 and 18). Some varieties are used not only for oil, but also for vegetables (Nos. 25, 27, 31, 32, 34, and 77).

We observed cultivation of *B. juncea* in each region of Myanmar, except for the Bagan area. In the Bagan area, a sandbank appears in the Ayeyarwady river when the water level goes down in the dry season. The commercial varieties introduced from China are cultivated only on these sandbanks, because of the high fertility of the soil in these spots.

Chinese kale (*Brassica oleracea* L.)

Chinese kale is used as a vegetable and it is important as a cash crop. Most of *B. oleracea* samples were collected around Katha township, and Chinese kale was sold in almost every market.

Radish (*Raphanus sativus* L.)

R. sativus is a root vegetable. It is sold in the market as a fresh vegetable. *R. sativus* samples with long root type for vegetable use were collected. In the Putao township, *R. sativus* is cultivated at the bottom of the riverbed that appears towards the end of the rainy season.

Discussion

B. juncea originated in Central Asia and has long been widely used as a vegetables, spice, and oil crop around the world. The secondary places of origin of *B. juncea*, for oil and vegetable use, seem to be India and China, respectively (Rakow 2014); we considered that Myanmar, located between China and India, must be the area responsible for the genetic diversity of *B. juncea*. This survey recognized that *B. juncea* has been used as a common vegetable in and around Kachin State in Myanmar, just as in the area surveyed last year. We observed wide variation in morphological traits.

The cropping season was different among the various areas in Myanmar. *B. juncea* can be cultivated all year round; thus, while the survey in Shan State allowed observation of various growth stages of *B. juncea*, in the present survey, only the seedling stage and short-term culture of *B. juncea* could be seen. From this, we confirmed that cropping season is different between the Shan State and the Kachin State.

In the southern Shan State, other vegetable crops within Brassicaceae, such as cabbage, cauliflower and Chinese kale are quite important vegetables as cash crop, such that they are cultivated and sold at many markets. However, in the surveyed area, vegetables such as cabbage or cauliflower were not registered, while Chinese kale had been cultivated in both Kachin State and Sagain State. Chinese kale is recognized as an important high-cash crop.

The use of *B. juncea* for oil was also recorded in this survey. The oil from the Brassica family accounts for more than 8%, and 11 million ha are cultivated with it. Among members of the Brassica family, *B. juncea* is recognized to show remarkable heat tolerance and drought resistance (Woods *et al.* 1991). The taste of mustard seed oil is especially acrid. The source of the acrid taste is allyl-isothiocyanate, which shows antibacterial properties, as well as repellent effects against insects. The mustard seed oil contains a high proportion of linoleic, linolenic, and erucic acids. Low erucic-acid oil is preferred for vegetable consumption (Wendlinger *et al.* 2014), while high erucic-acid oil is preferred for industrial purposes (Sharafi *et al.* 2015). Breeding for a double purpose variety (edible or industrial), both, extreme varieties with high and low erucic-acid oil are required. We believe that such cultivars exist among varieties of *B. juncea* in Myanmar.

Two surveys in Myanmar revealed a broad diversity of *B. juncea*, and some varieties are cultivated with seasonal limitations. Surveyed areas in Myanmar are still limited and do not cover the entire country. For this reason, further exploration into other areas of the country is essential for determining the overall diversity of *B. juncea* in Myanmar.

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ミャンマー北部カチン州及びその周辺地域における アブラナ科遺伝資源の探索収集

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和文摘要

ミャンマー連邦共和国のカチン州，ザガイン州およびモン州の一部において，アブラナ科遺伝資源の探索収集を行った。調査は2016年の8月21日～9月6日に実施した。ミャンマーにおける遺伝資源探索収集には，農業灌漑省農業研究局シードバンクを共同研究相手とし，「事前の情報に基づく同意 (PIC: Prior Informed Consent)」を得て現地調査を実施した。収集した遺伝資源は二分し，一方はミャンマー・シードバンクに保存し，他方は「標準材料移転契約 (SMTA: Standard Material Transfer Agreement)」を農業研究局と交わして日本に導入した。本調査によりカラシナ80点，カイラン7点，レタス1点，ダイコン13点の計101点のアブラナ科遺伝資源を収集した。ミャンマーの各地において，日常的な野菜としてカラシナが食されていることが確認された。また，特にカチン州においては重要な油糧作物としても認められており，利用されていた。ミャンマー国内においてはカラシナの栽培時期や用途の違いによる品種の多様性が見られたことから，今後も継続して他地域における探索を行う必要があると考えられる。

Table 3. A list of plant materials collected in 2016

Coll No	JP No	Species	Local name	Date of collection	Collection sites	Township	Name of village/market	Latitude	Longitude	Altitude (m)	Collection source	Usage
001	258557	<i>Brassica juncea</i> (L.) Czern	Chaula Mon Hnyin	25-Aug-16	Kachin State	Myitkyina	-	N25 23'08"	E097 24'07"	132	commercial market	leaf vegetable
002	258558	<i>Brassica juncea</i> (L.) Czern	Si Mon Hnyin	25-Aug-16	Kachin State	Myitkyina	-	N25 23'08"	E097 24'07"	132	commercial market	oil
003	258559	<i>Brassica juncea</i> (L.) Czern	Sein Mon Hnyin	25-Aug-16	Kachin State	Myitkyina	Kyet Paung Chan	N25 22'08"	E097 21'27"	97	farmland	leaf vegetable
004	258560	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin phyu	25-Aug-16	Kachin State	Myitkyina	Kyet Paung Chan	N25 22'08"	E097 21'27"	97	farmland	leaf vegetable
005	258561	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin phyu	25-Aug-16	Kachin State	Myitkyina	Kyet Paung Chan	N25 22'08"	E097 21'27"	97	farmland	leaf vegetable
006	258562	<i>Raphanus sativus</i> L.	White correct	25-Aug-16	Kachin State	Myitkyina	Kyet Paung Chan	N25 22'08"	E097 21'27"	97	farmland	vegetable
007	258563	<i>Raphanus sativus</i> L.	White correct	25-Aug-16	Kachin State	Myitkyina	Kyet Paung Chan	N25 22'08"	E097 21'27"	97	farmland	vegetable
008	258564	<i>Brassica juncea</i> (L.) Czern	Sein Mon Hnyin	25-Aug-16	Kachin State	Myitkyina	Kyet Paung Chan	N25 22'08"	E097 21'27"	97	farmland	leaf vegetable
009	258565	<i>Brassica juncea</i> (L.) Czern	Si Mon Hnyin "Tho rie"	25-Aug-16	Kachin State	Myitkyina	Kyet Paung Chan	N25 22'08"	E097 21'27"	97	farmland	leaf vegetable
010	258566	<i>Brassica juncea</i> (L.) Czern	Chaula Mon Hnyin	25-Aug-16	Kachin State	Myitkyina	Shwe set	N25 27'58"	E097 25'36"	172	farmland	leaf vegetable
011	258567	<i>Brassica juncea</i> (L.) Czern	Chaula Si Mon Hnyin	25-Aug-16	Kachin State	Myitkyina	-	N25 27'57"	E097 25'36"	173	institute	-
012	258568	<i>Brassica juncea</i> (L.) Czern	Chaula Mon Hnyin	25-Aug-16	Kachin State	Myitkyina	Myitkyina market	N25 23'02"	E097 24'06"	110	commercial market	leaf vegetable
013	258569	<i>Raphanus sativus</i> L.	Mon len u	25-Aug-16	Kachin State	Myitkyina	Myitkyina market	N25 23'02"	E097 24'06"	110	commercial market	vegetable
014	258570	<i>Brassica juncea</i> (L.) Czern	Si Mon Hnyin	25-Aug-16	Kachin State	Myitkyina	Myitkyina market	N25 23'02"	E097 24'06"	110	commercial market	oil
015	258571	<i>Brassica juncea</i> (L.) Czern	-	25-Aug-16	Kachin State	Myitkyina	Myitkyina market	N25 23'02"	E097 24'06"	110	commercial market	leaf vegetable
016	258572	<i>Brassica juncea</i> (L.) Czern	-	25-Aug-16	Kachin State	Myitkyina	Myitkyina market	N25 23'02"	E097 24'06"	110	commercial market	leaf vegetable
017	258573	<i>Brassica juncea</i> (L.) Czern	Kyo Kyat Mon Hnyin	25-Aug-16	Kachin State	Myitkyina	Myitkyina market	N25 23'02"	E097 24'06"	110	commercial market	leaf vegetable
018	258574	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	Kai lan	25-Aug-16	Kachin State	Myitkyina	Myitkyina market	N25 23'02"	E097 24'06"	110	commercial market	vegetable
019	258575	<i>Lactuca sativa</i> L.	-	25-Aug-16	Kachin State	Myitkyina	Myitkyina market	N25 23'02"	E097 24'06"	110	commercial market	vegetable
020	258576	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin phyu	26-Aug-16	Kachin State	Putao	Pan Hlaing	N27 21'40"	E097 24'02"	402	farmland	leaf vegetable
021	258577	<i>Raphanus sativus</i> L.	Noha	26-Aug-16	Kachin State	Putao	Pan Hlaing	N27 21'40"	E097 24'02"	402	farmland	leaf vegetable
022	258578	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin □ mix	26-Aug-16	Kachin State	Putao	-	N27 21'26"	E097 23'51"	-	farmland	oil
023	258579	<i>Brassica juncea</i> (L.) Czern	-	26-Aug-16	Kachin State	Putao	Putao	N27 20'43"	E097 24'06"	418	farmland	oil
024	258580	<i>Brassica juncea</i> (L.) Czern	Si Mon Hnyin	26-Aug-16	Kachin State	Putao	Putao	N27 20'43"	E097 24'06"	418	farmland	oil
025	258581	<i>Brassica juncea</i> (L.) Czern	Si Mon Hnyin	26-Aug-16	Kachin State	Machanbaw	Machan baw	N27 17'01"	E097 35'12"	384	farmland	oil / leaf vegetable
026	258582	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	26-Aug-16	Kachin State	Putao	Nagngkhaing	N27 16'14"	E097 34'58"	490	farmland	leaf vegetable
027	258583	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	26-Aug-16	Kachin State	Putao	Nagngkhaing	N27 16'14"	E097 34'58"	490	farmland	oil / leaf vegetable
028	258584	<i>Raphanus sativus</i> L.	Mon len u	27-Aug-16	Kachin State	Putao	Putao market	N27 20'31"	E097 24'03"	403	commercial market	-
029	258585	<i>Brassica juncea</i> (L.) Czern	Chaula Mon Hnyin	27-Aug-16	Kachin State	Putao	Hta wa dann	N27 22'41"	E097 31'54"	432	farmland	leaf vegetable
030	258586	<i>Raphanus sativus</i> L.	Mon len u	27-Aug-16	Kachin State	Putao	Hta wa dann	N27 22'41"	E097 31'54"	432	farmland	vegetable
031	258587	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	27-Aug-16	Kachin State	Putao	cow mo don	N27 23'04"	E097 31'56"	367	farmland	oil / leaf vegetable
032	258588	<i>Brassica juncea</i> (L.) Czern	Si Mon Hnyin	27-Aug-16	Kachin State	Putao	cow mo don	N27 23'04"	E097 31'56"	367	farmland	oil / leaf vegetable
033	258589	<i>Raphanus sativus</i> L.	Mon len u	27-Aug-16	Kachin State	Putao	cow mo don	N27 23'04"	E097 31'56"	367	farmland	leaf vegetable
034	258590	<i>Brassica juncea</i> (L.) Czern	Si Mon Hnyin	27-Aug-16	Kachin State	Putao	Zae Ri Ta	N27 22'37"	E097 31'32"	439	farmland	oil / leaf vegetable
035	258591	<i>Raphanus sativus</i> L.	Mon len u	27-Aug-16	Kachin State	Putao	Zae Ri Ta	N27 22'37"	E097 31'32"	439	farmland	vegetable
036	258592	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	27-Aug-16	Kachin State	Putao	Zae Ri Ta	N27 21'09"	E097 29'06"	428	farmland	leaf vegetable
037	258593	<i>Brassica juncea</i> (L.) Czern	Chaula Mon Hnyin	27-Aug-16	Kachin State	Putao	Zae Ri Ta	N27 21'09"	E097 29'06"	428	farmland	leaf vegetable
038	258594	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	27-Aug-16	Kachin State	Putao	Land Non	N27 14'23"	E097 28'27"	475	farmland	leaf vegetable
039	258595	<i>Brassica juncea</i> (L.) Czern	Si Mon Hnyin	27-Aug-16	Kachin State	Putao	Land Non	N27 14'23"	E097 28'27"	475	farmland	leaf vegetable
040	258596	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	27-Aug-16	Kachin State	Putao	Phat marti	N27 12'37"	E097 30'32"	395	farmland	leaf vegetable
041	258597	<i>Brassica juncea</i> (L.) Czern	Si Mon Hnyin	27-Aug-16	Kachin State	Putao	Putao	N27 20'47"	E097 24'05"	424	institute	oil

Table 3. (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
042	258598	<i>Brassica juncea</i> (L.) Czern	Si Mon Hnyin	27-Aug-16	Kachin State	Putao	Putao	N27 20'47"	E097 24'05"	424	institute	oil
043	258599	<i>Brassica juncea</i> (L.) Czern	Si Mon Hnyin	27-Aug-16	Kachin State	Putao	Putao	N27 20'47"	E097 24'05"	424	institute	oil
044	258600	<i>Brassica juncea</i> (L.) Czern	Si Mon Hnyin	27-Aug-16	Kachin State	Putao	Man sae	N27 24'25"	E097 21'04"	366	farmland	oil
045	258601	<i>Brassica juncea</i> (L.) Czern	Chaula Mon Hnyin	27-Aug-16	Kachin State	Putao	Man sae	N27 24'25"	E097 21'04"	366	farmland	leaf vegetable
046	258602	<i>Brassica juncea</i> (L.) Czern	Chaula Mon Hnyin	27-Aug-16	Kachin State	Putao	Man sae	N27 24'25"	E097 21'04"	366	farmland	leaf vegetable
047	258603	<i>Brassica juncea</i> (L.) Czern	Chaula Mon Hnyin	27-Aug-16	Kachin State	Putao	Man sae	N27 24'25"	E097 21'04"	366	farmland	leaf vegetable
048	258604	<i>Raphanus sativus</i> L	Mon len u	27-Aug-16	Kachin State	Putao	Man sae	N27 24'25"	E097 21'04"	366	farmland	vegetable
049	258605	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin phyu	27-Aug-16	Kachin State	Putao	Man sae	N27 24'25"	E097 21'04"	366	farmland	leaf vegetable
050	258606	<i>Raphanus sativus</i> L	Mon len u	28-Aug-16	Kachin State	Putao	Kyo khu	N27 21'24"	E097 23'55"	399	commercial market	vegetable
051	258607	<i>Raphanus sativus</i> L	Mon len u	28-Aug-16	Kachin State	Myitkyina	A lel kone	N25 21'06"	E097 24'19"	140	farmland	vegetable
052	258608	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	28-Aug-16	Kachin State	Myitkyina	A lel kone	N25 21'06"	E097 24'19"	140	farmland	leaf vegetable
053	258609	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	29-Aug-16	Kachin State	Mingin	Za conne	N25 18'12"	E096 56'17"	98	commercial market	leaf vegetable
054	258610	<i>Brassica juncea</i> (L.) Czern	Si Mon Hnyin	29-Aug-16	Kachin State	Mingin	Za conne	N25 18'12"	E096 56'17"	98	commercial market	leaf vegetable
055	258611	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	29-Aug-16	Kachin State	Mingin	Ka Kyin Myin	N25 13'57"	E096 46'03"	158	farmland	leaf vegetable
056	258612	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	29-Aug-16	Kachin State	Mohnyin	Hopin market	N24 59'14"	E096 31'33"	244	commercial market	leaf vegetable
057	258613	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	29-Aug-16	Kachin State	Mohnyin	Hopin market	N24 59'14"	E096 31'33"	244	commercial market	leaf vegetable
058	258614	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	29-Aug-16	Kachin State	Mohnyin	Hopin market	N24 59'14"	E096 31'33"	244	commercial market	leaf vegetable
059	258615	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin "Go Gar"	29-Aug-16	Kachin State	Mohnyin	Hopin market	N24 59'14"	E096 31'33"	244	commercial market	leaf vegetable
060	258616	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	29-Aug-16	Kachin State	Mohnyin	Hopin market	N24 59'14"	E096 31'33"	230	commercial market	leaf vegetable
061	258617	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	29-Aug-16	Sagaing State	Katha	Land Gwa	N24 13'55"	E096 17'55"	300	farmland	leaf vegetable
062	258618	<i>Brassica juncea</i> (L.) Czern	Si Mon Hnyin	30-Aug-16	Sagaing State	Katha	Katha market	N24 10'28"	E096 29'29"	39	commercial market	leaf vegetable
063	258619	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	30-Aug-16	Sagaing State	Katha	Katha market	N24 10'28"	E096 29'29"	39	commercial market	leaf vegetable
064	258620	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	30-Aug-16	Sagaing State	Katha	Katha market	N24 10'28"	E096 29'29"	39	commercial market	leaf vegetable
065	258621	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	30-Aug-16	Sagaing State	Katha	Katha market	N24 10'28"	E096 29'29"	39	commercial market	leaf vegetable
066	258622	<i>Brassica juncea</i> (L.) Czern	Si Mon Hnyin	30-Aug-16	Sagaing State	Katha	Katha market	N24 10'28"	E096 29'29"	39	commercial market	leaf vegetable
067	258623	<i>Raphanus sativus</i> L	Mon len u	30-Aug-16	Sagaing State	Katha	Katha market	N24 10'28"	E096 29'29"	39	commercial market	vegetable
068	258624	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	30-Aug-16	Sagaing State	Katha	Ka Pa Late	N24 12'16"	E096 21'47"	98	farmland	leaf vegetable
069	258625	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	Kai lan	30-Aug-16	Sagaing State	Katha	Ka Pa Late	N24 12'16"	E096 21'47"	98	farmland	vegetable
070	258626	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	30-Aug-16	Sagaing State	Katha	Ka Pa Late	N24 12'16"	E096 21'47"	98	farmland	leaf vegetable
071	258627	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	Kyawn Kai Lan	30-Aug-16	Sagaing State	Katha	Ka Pa Late	N24 12'16"	E096 21'47"	98	farmland	vegetable
072	258628	<i>Brassica juncea</i> (L.) Czern	Kyawt siat	30-Aug-16	Sagaing State	Katha	Thor sii	N24 13'00"	E096 22'33"	87	farmland	leaf vegetable
073	258629	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	30-Aug-16	Sagaing State	Katha	Thor sii	N24 13'00"	E096 22'33"	87	farmland	leaf vegetable
074	258630	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	30-Aug-16	Sagaing State	Katha	Nant Laing	N24 13'26"	E096 21'03"	93	farmland	leaf vegetable
075	258631	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	30-Aug-16	Sagaing State	Katha	Nant Laing	N24 13'26"	E096 21'03"	93	farmland	leaf vegetable
076	258632	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	30-Aug-16	Sagaing State	Katha	Migalar Thu Ka	N24 14'44"	E096 22'53"	115	farmland	leaf vegetable
077	258633	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	30-Aug-16	Sagaing State	Katha	Migalar Thu Ka	N24 14'44"	E096 22'53"	115	farmland	oil / leaf vegetable
078	258634	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	30-Aug-16	Sagaing State	Katha	Phy Thar Yar	N24 10'40"	E096 19'27"	123	farmland	leaf vegetable
079	258635	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	30-Aug-16	Sagaing State	Katha	Phy Thar Yar	N24 10'40"	E096 19'27"	124	farmland	leaf vegetable
080	258636	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	Kai lan	30-Aug-16	Sagaing State	Katha	Phy Thar Yar	N24 10'40"	E096 19'27"	124	farmland	vegetable
081	258637	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	Kai lan	30-Aug-16	Sagaing State	Katha	Thein Inn	N24 10'35"	E096 19'30"	118	farmland	vegetable
082	258638	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	30-Aug-16	Sagaing State	Katha	Thein Inn	N24 10'35"	E096 19'30"	118	farmland	leaf vegetable

Table 3. (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
083	258639	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	Mustard Kai lan	30-Aug-16	Sagaing State	Katha	Thein Inn	N24 10'35"	E096 19'30"	118	farmland	vegetable
084	258640	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	30-Aug-16	Sagaing State	Katha	Bon Gon	N24 09'18"	E096 19'58"	109	farmland	leaf vegetable
085	258641	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	30-Aug-16	Sagaing State	Katha	Bon Gon	N24 09'11"	E096 19'51"	68	farmland	leaf vegetable
086	258642	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	30-Aug-16	Sagaing State	Katha	Aung Chan Thar	N24 08'38"	E096 19'51"	88	farmland	leaf vegetable
087	258643	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	31-Aug-16	Sagaing State	Kawlin	Doe Pin	N23 53'31"	E095 55'52"	202	farmland	leaf vegetable
088	258644	<i>Raphanus sativus</i> L.	-	31-Aug-16	Sagaing State	Kawlin	Kan thar market	N24 47'01"	E095 53'28"	193	commercial market	vegetable
089	258645	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	31-Aug-16	Sagaing State	Kawlin	Kan thar market	N24 47'01"	E095 53'28"	193	commercial market	leaf vegetable
090	258646	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	31-Aug-16	Sagaing State	Kawlin	Pail cone	N23 45'31"	E095 52'12"	180	farmland	fruit
091	258647	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	31-Aug-16	Sagaing State	Monywa	Za Lo Ka	-	-	-	farmland	leaf vegetable
092	258648	<i>Brassica oleracea</i> L. <i>Alboglabra</i> Group	-	31-Aug-16	Sagaing State	Monywa	Kyonr Paint	N22 02'30"	E095 11'01"	110	farmland	vegetable
093	258649	<i>Brassica juncea</i> (L.) Czern	Chaula Mon Hnyin	31-Aug-16	Sagaing State	Chaung U	Khim tea	-	-	-	institute	leaf vegetable
094	258650	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	31-Aug-16	Sagaing State	Chaung U	Khim tea	-	-	-	institute	leaf vegetable
095	258651	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	31-Aug-16	Sagaing State	Chaung U	Khim tea	-	-	-	institute	leaf vegetable
N-1	258652	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	13-Aug-16	Mon State	Mudon	Seed shop	N16 15'25"	E097 43'25"	34	commercial market	leaf vegetable
N-2	258653	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	13-Aug-16	Mon State	Mudon	Seed shop	N16 15'25"	E097 43'25"	34	commercial market	leaf vegetable
N-3	258654	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	19-Aug-16	Kayin State	Myawaddy	Market	N16 41'12"	E098 29'57"	227	commercial market	leaf vegetable
N-4	258655	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	19-Aug-16	Kayin State	Myawaddy	Market	N16 15'25"	E097 43'25"	227	commercial market	leaf vegetable
N-5	258656	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	20-Aug-16	Mon State	Thaton	Seed shop	N16 54'55"	E097 22'00"	221	commercial market	leaf vegetable
N-6	258657	<i>Brassica juncea</i> (L.) Czern	Mon Hnyin	20-Aug-16	Mon State	Thaton	Seed shop	N16 54'55"	E097 22'00"	221	commercial market	leaf vegetable



Photograph 1. Soup of the *B. juncea*



Photograph 2. Fresh vegetables of *B. juncea*



Photograph 3. Fresh vegetables of *B. juncea*



Photograph 4. Fresh vegetables of *B. juncea*



Photograph 5. Pickle of *B. juncea*



Photograph 6. Pickle shop



Photograph 7. Mustard cultivated under the leaves



Photograph 8. Mustard production



Photograph 9. Shipping preparation of *B. juncea*



Photograph 10. Seedling stage of *B. juncea*



Photograph 11. Nursery box of *B. juncea*



Photograph 12. Seeds of various crop of seed shop



Photograph 13. Saved seeds



Photograph 14. Seed preservation method of Lisu



Photograph 15. Processing plant of mustard oil



Photograph 16. Ripped fresh oil



Photograph 17. Oil millet



Photograph 18. Oil millet (feedstuff)