

## Collaborative Exploration of Cucurbitaceae Vegetable Genetic Resources in Myanmar 2019

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# Collaborative Exploration of Cucurbitaceae Vegetable Genetic Resources in Myanmar in 2019

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## Summary

This study describes the exploration of genetic resources of cucurbitaceous vegetables in northwestern Myanmar, Sagaing region, and this study was jointly conducted by the National Agriculture and Food Research Organization (NARO), Japan, and the Department of Agriculture Research, Myanmar. A field survey was conducted in northwestern Myanmar from November 1 to 17, 2019. We collected a total of 24 accessions, 16 from *Cucumis sativus* L., two from *Cucumis melo* L., three from *Cucurbita moschata* Duchense, one from *Cucurbita maxima* Duchense ex Lam., one from *Luffa acutangula* (L.) Roxb., and one from *Momordica charantia* L. The collected accessions were stored as seeds at the Myanmar Seed Bank and subsets were transferred to the Genetic Resources Center, NARO, using a standard material transfer agreement.

KEY WORDS: Myanmar, genetic resources, cucumber, pumpkin, melon

## Introduction

Myanmar is a large country, ranging from the southern coastal area to the northwestern mountainous area. The Sagaing region is located in the northwestern part of Myanmar and is bordered by India's Nagaland state. These hilly and mountainous areas are inhabited by ethnic groups, mainly several Naga tribes, who perform traditional agricultural practices and grow diverse traditional crops. They cultivate these varieties in slash-and-burn cultivation fields, home gardens, and terrace cultivation fields. The practice of the collection of novel plant genetic resources, which has been passed down within these ethnic groups, is crucial for the development

of new varieties that harbor desirable traits, such as disease and pest resistance, improved fruit quality, and higher yields.

This area is of great importance considering the diversity of cucurbitaceous plants. In particular, cucumber is considered to have originated around the southern Himalayan region and introduced to other parts of the world (de Candolle 1886; Bisht *et al.* 2004). Thus, Myanmar is believed to be a promising source of genetic variability for cucurbits (Saito *et al.* 2006; Kawase *et al.* 2011; Yamamoto *et al.* 2011; Domon *et al.* 2015; Naito *et al.* 2017; Min San Thein *et al.* 2017; Ohm Mar Saw *et al.* 2018). We expected to find genetic resources with

a wide variety of important agronomical traits, such as fruit shape, pest, disease, and environmental stress resistance, among others. Here, we report the results of a genetic-resource-survey trip in the northwestern part of Myanmar, Sagaing region.

## Methods

From November 1 to 17, 2019, the collection of vegetable genetic resources in the Sagaing region was undertaken (Table 1). Japanese members arrived at Yangon International Airport from Japan on November 1, 2019, and joined the Myanmar Seed Bank members. The next day, this exploratory party moved to Khamti via the Mandalay International Airport by air. We collected the genetic resources available at Khamti, Lahe, and Layshi townships belonging to the Khamti district, Sagaing region. Fruit and seed samples of local varieties were collected from farmers and markets at 13 sites (Fig. 1). Information on each sample was collected via interviews, and this data included the local plant name, sowing date, harvest date, usage, and cultivation methods (Table 2). In addition, the place name and precise latitude and longitude of the collection sites were recorded using Garmin eTrex20J GPS technology (Garmin International Inc., Olathe, KS, USA). The collected accessions were stored as seeds at the Myanmar Seed Bank and subsets were transferred to the Genetic Resources Center, National Agriculture and Food Research Organization (NARO), using a standard material transfer agreement.

## Results and Discussion

The Sagaing region, located in northwestern Myanmar, is a hilly and mountainous area (Photo 1).



Photo 1. Landscape of a forest in the Sagaing region

Three townships in this area, Lahe, Layshi, and Nanyun, belong to the Naga Self-Administered Zone (Naga SAZ). This zone is self-administrated by the Naga tribals. Two-thirds of the Naga inhabitants in Myanmar are Christians and one-third are Buddhists. Previous studies on the Naga SAZ have shown that the Naga inhabitants have been growing a range of traditional crops and varieties, mainly in a conventional slash-and-burn cultivation scheme in fields, as well as in home gardens and terraces. Additionally, they collect useful plants from their surrounding environment (Kawase *et al.* 2011; Yamamoto *et al.* 2011; Domon *et al.* 2015; Min San Thein *et al.* 2017; Naito *et al.* 2017). In this study, a total of 24 samples were collected, including 16 samples from *Cucumis sativus* L., two from *Cucumis melo* L., three from *Cucurbita moschata* Duchense, one from *Cucurbita maxima* Duchense ex Lam., one from *Luffa acutangula* (L.) Roxb., and one from *Momordica charantia* L (Table 3).

Table 1. Itinerary of the field survey in the Sagaing region, 2019

| Date (month/day) | Day | Itinerary                       | Stay        |
|------------------|-----|---------------------------------|-------------|
| 11/1             | Fri | Narita - Yangon                 | Yangon      |
| 11/2             | Sat | Yangon - Mandalay - Khamti      | Khamti      |
| 11/3             | Sun | Khamti - Lahe                   | Lahe        |
| 11/4             | Mon | Lahe                            | Lahe        |
| 11/5             | Tue | Lahe - Khamti                   | Khamti      |
| 11/6             | Wed | Khamti - Hta Man Thi - Layshi   | Layshi      |
| 11/7             | Thu | Layshi                          | Layshi      |
| 11/8             | Fri | Layshi                          | Layshi      |
| 11/9             | Sat | Layshi                          | Layshi      |
| 11/10            | Sun | Layshi                          | Layshi      |
| 11/11            | Mon | Layshi - Hta Man Thi - Khamti   | Khamti      |
| 11/12            | Tue | Khamti - Mandalay - Nay Pyi Taw | Nay Pyi Taw |
| 11/13            | Wed | Maynmar Seed Bank (Yezin)       | Nay Pyi Taw |
| 11/14            | Thu | Nay Pyi Taw - Yangon            | Yangon      |
| 11/15            | Fri | Yangon                          | Yangon      |
| 11/16            | Sat | Yangon - Narita (11/17)         | On flight   |

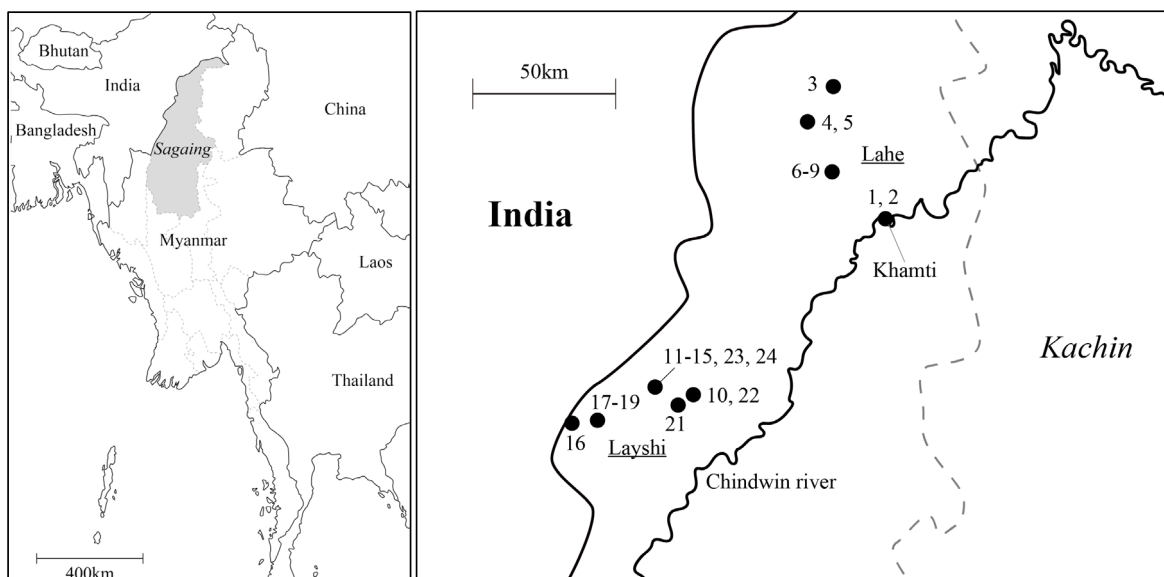


Fig. 1. Map showing the northwestern part of Myanmar. The gray shaded area is the Sagaing region (left). Figures show the number of cucumber accessions collected in each location (describe without “MYC-” of collection ID) at Khamti, Lahe, and Layshi township, and around villages (right).

Table 2. Summary of the collected genetic resources in the Sagaing region, Myanmar, 2019

| Species                    | Total     |
|----------------------------|-----------|
| <i>Cucumis sativus</i>     | 16        |
| <i>Cucurbita moschata</i>  | 3         |
| <i>Cucumis melo</i>        | 2         |
| <i>Cucurbita maxima</i>    | 1         |
| <i>Luffa acutangula</i>    | 1         |
| <i>Momordica charantia</i> | 1         |
| <b>Total</b>               | <b>24</b> |



Photo 2. The main transportation method is by boat between Khamti and Hta Man Thi along the Chindwin River.

Khamti is the principal township in the Khamti district in the Sagaing region, along the Chindwin River (Photo 2). It is a warm area, where the average annual maximum temperature is approximately 30 °C. There is a relatively large market in the township, namely the Khamti market, where many species of crops are sold as local food sources, including Cucurbitaceae vegetables (Photo 3). We collected the seeds of pumpkin and ridge gourd (MYC-1 and 2, respectively), which were sown from September to November, and harvested from December to February. In the area around the Khamti township, farmers can cultivate crops throughout the year owing to the area’s warm weather conditions.



Photo 3. A variety of vegetables being displayed at a large local market, namely the Khamti market.

Lahe is another one of the principal townships in the Khamti district. The town and surrounding villages are inhabited by ethnic people, who follow their own cultures, traditions, and languages. Lahe is located approximately 1,000 m above sea level, and we collected genetic resources from one village that is over 1,300 m

above sea level (Photos 4-8). We collected four genetic resources from cucumbers (MYC-5, 6, 8 and 9), two from a melon (MYC-3 and 7), and one from bitter gourd (MYC-4). Some cucumbers were transferred from other areas, such as the Chin state and Gangaw district.



Photo 4. Slash-and-burn cultivation fields in Lahe township, where upland rice was cultivated; banana (that might be wild) was grown nearby.



Photo 7. Vegetables displayed at a local marketplace in Lahe township



Photo 5. A distant view of San ton village located on a slope approximately 1,300 m above sea level.



Photo 8. View of Lahe township. Its elevation is approximately 1,000 m above sea level.



Photo 6. Various crop seeds received from the village mayor in San ton



Photo 9. A traditional festival of Naga tribe being held in Layshi township.

Layshi is located in the forestry highland at approximately 1,300 m above sea level. The villages in this township are also inhabited by ethnic groups, mostly of the Naga tribes (Photo 9). We obtained cucumber and pumpkin samples that were collected from the Tung Kun Naga, Para Naga, and Makuri Naga tribes in this area. The Naga tribes practice different religions, e.g., Christianity or Buddhism, depending on each tribe, and they maintain their own cultures, traditions, and languages. Somra town and Kong Kai Lon Ywa Ma

village are located close to the border shared with India, and these were the highest sites, approximately 1,900 m above sea level, from where we collected cucumber genetic resources. In Layshi, we collected 12 samples from cucumbers (MYC-10-12 and 16-24), two from *Cucurbita moschata* (MYC-13 and 14), and one from *Cucurbita maxima* (MYC-15) (Photos 10-12). The weather conditions at Lahe, Layshi, and the villages around these areas were cooler than that at Khanti. The collected accessions were stored as seeds at the



Photo 10. Farmers cultivated cucumber in their farmland using trellis. A mature fruit was used for stir-frying with other ingredient and obtaining seeds of the next generation.



Photo 11. An immature fruit of cucumber with white skin color (left) becomes brown as the fruit matures (right).



Photo 12. A farmer cultivating *C. maxima*, taking care of the fruits to prevent physical damage.

Myanmar Seed Bank and subsets were transferred to the Genetic Resources Center, NARO.

We collected 17 samples from fruits and seven from seeds. In the cucumber, a variety was observed in sample morphologies. Skin colors were orange, green, yellow, brown, and white in the mature fruit stage. Some flesh color was orange, suggesting that they might accumulate carotene during the mature stage. Almost all fruits were cylindrical; however, MYC-19 was round. The sowing season was from April to May and harvesting from

August to November in Lahe, and sowing from April to July and harvesting from September to November in Layshi. The sowing and harvesting times varied depending on the climatic conditions of each farm area, such as altitude and temperature. People use cucumber fruits for fresh vegetables at the immature stage, stir-frying with other ingredients. We collected one *Cucurbita maxima* that is rarely found in this area. The farmers informed us that they obtained *Cucurbita maxima* from India a long time ago, and these are sweeter and more delicious than other pumpkins. The farmers have been maintaining the growth of this pumpkin with care, to prevent damage from disease, insects, and other animal attacks.

#### Acknowledgments

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# ミャンマーにおける野菜遺伝資源の共同探索，2019年

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## 和文摘要

本報告は農林水産省委託プロジェクト研究「海外植物遺伝資源の収集・提供強化」の予算により実施され、国立研究開発法人農業・食品産業技術総合研究機構とミャンマー植物遺伝資源センターとの間で行われたミャンマー北西部ザガイン管区におけるウリ科野菜遺伝資源の探索・収集に関わる調査報告書である。調査は2019年11月1日～17日にかけて行った。カムティ省のカムティ郡、ラヘ郡、レイシ郡において探索・調査を行った。その結果、キュウリ (*Cucumis sativus*) 16点、ニホンカボチャ (*Cucurbita moschata*) 3点、メロン (*Cucumis melo*) 2点、セイヨウカボチャ (*Cucurbita maxima*)、トカドヘチマ (*Luffa acutangula*) およびツルレイシ (*Momordica charantia*) の計24点の野菜遺伝資源を収集した。収集された遺伝資源種子の半分はミャンマー農業研究局シードバンクで保存され、残りはSMTAを用いて国立研究開発法人農業・食品産業技術総合研究機構ジーンバンクに移転された。



Table 3. List of genetic resources collected in Myanmar during the 2019 survey

| Coll. ID | JP No. | Coll. Date<br>Nov. 2019 | Species<br>name                | Local name         | Type of<br>sample | Status of<br>sample | Coll.<br>Source   | Division | District | Township | Town or<br>village name | Latitude     | Longitude    | Altitude<br>(m) | Remarks  |
|----------|--------|-------------------------|--------------------------------|--------------------|-------------------|---------------------|-------------------|----------|----------|----------|-------------------------|--------------|--------------|-----------------|--|
| MYC-1    | 270780 | 3                       | <i>Cucurbita<br/>moschata</i>  | Shwe Pha<br>Yone   | Landrace          | Seed                | Village<br>market | Sagaing  | Khamti   | Khamti   | Khamti                  | N26-00-05.42 | E95-41-30.04 | 155             | Collected at "Khamti market"; sowing from<br>Sep. to Nov., harvesting from Dec. to Feb.;<br>stewing and stir frying  |
| MYC-2    | 270781 | 3                       | <i>Luffa<br/>acutangula</i>    | Kha Wae            | Landrace          | Seed                | Village<br>market | Sagaing  | Khamti   | Khamti   | Khamti                  | N26-00-05.42 | E95-41-30.04 | 155             | Collected at "Khamti market"; sowing from<br>Sep. to Nov., harvesting from Dec. to Feb.;<br>stewing and stir frying  |
| MYC-3    | 270782 | 4                       | <i>Cucumis<br/>melo</i>        | Khon Cho<br>The    | Landrace          | Seed                | Farmstore         | Sagaing  | Khamti   | Lahe     | San Ton                 | N26-26-17.82 | E95-31-38.89 | 1,333           |  |
| MYC-4    | 270783 | 4                       | <i>Momordica<br/>charantia</i> | Khao Sha           | Landrace          | Fruit               | Farmland          | Sagaing  | Khamti   | Lahe     | Lahe                    | N26-19-28.41 | E95-25-27.87 | 987             |  |
| MYC-5    | 270784 | 5                       | <i>Cucumis<br/>sativus</i>     | Tha<br>Khuwar      | Landrace          | Fruit               | Village<br>market | Sagaing  | Khamti   | Lahe     | Lahe                    | N26-19-24.69 | E95-26-31.53 | 987             | Collected at "Lahe market"; sowing in<br>Mar., harvesting in Nov.; making salad at<br>immature, soup at mature fruit   |
| MYC-6    | 270785 | 5                       | <i>Cucumis<br/>sativus</i>     | Tha<br>Khuwar      | Landrace          | Seed                | Farmstore         | Sagaing  | Khamti   | Lahe     | Laung Naguk             | N26-09-22.97 | E95-31-16.21 | 883             | Landrace from Gangaw area; sowing from<br>Apr. to May; harvesting from Aug. to Sep.;<br>making salad, soup and stir frying with meet   |
| MYC-7    | 270786 | 5                       | <i>Cucumis<br/>melo</i>        | Tha Khuwar<br>Ma   | Landrace          | Seed                | Farmland          | Sagaing  | Khamti   | Lahe     | Laung Naguk             | N26-09-22.97 | E95-31-16.21 | 883             | Landrace from Gangaw area  |
| MYC-8    | 270787 | 5                       | <i>Cucumis<br/>sativus</i>     | Tha<br>Khuwar      | Landrace          | Fruit               | Farmland          | Sagaing  | Khamti   | Lahe     | Laung Naguk             | N26-09-22.97 | E95-31-16.21 | 883             |  |
| MYC-9    | 270788 | 5                       | <i>Cucumis<br/>sativus</i>     | Tha<br>Khuwar      | Landrace          | Fruit               | Farmland          | Sagaing  | Khamti   | Lahe     | Laung Naguk             | N26-09-22.97 | E95-31-16.21 | 883             |  |
| MYC-10   | 270789 | 6                       | <i>Cucumis<br/>sativus</i>     | Sam Moai           | Landrace          | Fruit               | Farmland          | Sagaing  | Khamti   | Layshi   | 25 mile                 | N25-26-52.59 | E95-04-31.90 | 643             | Landrace from Chin area; sowing in Jun.,<br>harvesting in Nov.; making salad, stir frying  |
| MYC-11   | 270790 | 7                       | <i>Cucumis<br/>sativus</i>     | Yge                | Landrace          | Fruit               | Farmland          | Sagaing  | Khamti   | Layshi   | Sap Pyar                | N25-30-03.38 | E94-56-33.48 | 1,104           | Sowing from Apr. to May, harvesting in<br>Nov.; making salad, stir frying with chilli<br>pepper  |
| MYC-12   | 270791 | 7                       | <i>Cucumis<br/>sativus</i>     | Yge                | Landrace          | Fruit               | Farmland          | Sagaing  | Khamti   | Layshi   | Pain Ne Gone            | N25-29-06.92 | E94-57-59.87 | 935             | Received from "Para Naga" tribe people;<br>sowing from Jun. to Jul., harvesting from<br>Sep. to Oct.; making salad   |
| MYC-13   | 270792 | 7                       | <i>Cucurbita<br/>moschata</i>  | Qhai<br>Mpwai      | Landrace          | Fruit               | Farmland          | Sagaing  | Khamti   | Layshi   | Pain Ne Gone            | N25-29-06.92 | E94-57-59.87 | 935             | Received from "Para Naga" tribe people;<br>sowing from Jun. to Jul., harvesting in Oct.;<br>After boiling, making soup and stir frying<br>with meet or other vegetables      |
| MYC-14   | 270793 | 7                       | <i>Cucurbita<br/>moschata</i>  | Qhai Mpwai<br>Toto | Landrace          | Fruit               | Farmland          | Sagaing  | Khamti   | Layshi   | Pain Ne Gone            | N25-29-06.92 | E94-57-59.87 | 935             | Received from "Para Naga" tribe people;<br>"Toto" means white skin; sowing in Jun.,<br>harvesting in Oct.; boiling for soup and stir<br>frying with meet or other vegetables |
| MYC-15   | 270794 | 7                       | <i>Cucurbita<br/>maxima</i>    | Qhai Mpwai<br>Toto | Landrace          | Fruit               | Farmland          | Sagaing  | Khamti   | Layshi   | Pain Ne Gone            | N25-29-06.92 | E94-57-59.87 | 935             | Received from "Para Naga" tribe people;<br>"Toto" means white skin; sowing in Jun.,<br>harvesting in Oct.; boiling for soup and stir<br>frying with meet or other vegetables |

Table 3. (Continued).

| Coll. ID | JP No. | Coll. Date<br>Nov. 2019 | Species<br>name            | Local name | Type of<br>sample | Status of<br>sample | Coll.<br>Source | Division | District | Township | Town or<br>village name  | Latitude     | Longitude    | Altitude<br>(m) | Remarks  |
|----------|--------|-------------------------|----------------------------|------------|-------------------|---------------------|-----------------|----------|----------|----------|--------------------------|--------------|--------------|-----------------|--|
| MYC-16   | 270795 | 8                       | <i>Cucumis<br/>sativus</i> | Yin Tie    | Landrace          | Fruit               | Farmland        | Sagaing  | Khamti   | Layshi   | Somra                    | N25-21-51.03 | E94-41-15.61 | 1,894           | Received from "Tung Kun Naga" tribe<br>people; sowing from May to Jun., harvesting<br>from Oct. to Nov.; making salad, using<br>dried fruit in the absence of flesh fruit                |
| MYC-17   | 270796 | 8                       | <i>Cucumis<br/>sativus</i> | Yin Tie    | Landrace          | Fruit               | Farmland        | Sagaing  | Khamti   | Layshi   | Kong Kai<br>Lon Ywa Ma   | N25-22-07.77 | E94-45-50.99 | 1,907           | Received from "Tung Kun Naga" tribe<br>people; sowing from Jun. to Jul., harvesting<br>in Sep.; making salad at immature, stir<br>frying with meet or other vegetable at<br>mature fruit |
| MYC-18   | 270797 | 8                       | <i>Cucumis<br/>sativus</i> | Yin Tie    | Landrace          | Seed                | Farmland        | Sagaing  | Khamti   | Layshi   | Kong Kai<br>Lon Ywa Ma   | N25-22-07.77 | E94-45-50.99 | 1,907           | Received from "Tung Kun Naga" tribe<br>people; sowing from Jun. to Jul., harvesting<br>in Sep.; making salad at immature, stir<br>frying with meet or other vegetable at<br>mature fruit |
| MYC-19   | 270798 | 8                       | <i>Cucumis<br/>sativus</i> | Yin Tie    | Landrace          | Fruit               | Farmland        | Sagaing  | Khamti   | Layshi   | Kong Kai<br>Lon Ywa Ma   | N25-22-07.77 | E94-45-50.99 | 1,907           | Received from "Tung Kun Naga" tribe<br>people; sowing from Jun. to Jul., harvesting<br>in Sep.; making salad at immature, stir<br>frying with meet or other vegetable at<br>mature fruit |
| MYC-20   | 270799 | 8                       | <i>Cucumis<br/>sativus</i> | Yin Tie    | Landrace          | Fruit               | Farmland        | Sagaing  | Khamti   | Layshi   | Kong Kai<br>Lon Ywa Ma   | N25-22-07.77 | E94-45-50.99 | 1,907           | Received from "Tung Kun Naga" tribe<br>people; sowing from Jun. to Jul., harvesting<br>in Sep.; using flesh fruit only for hydration   |
| MYC-21   | 270800 | 9                       | <i>Cucumis<br/>sativus</i> | Zam Mai    | Landrace          | Fruit               | Farmland        | Sagaing  | Khamti   | Layshi   | Sone Kin                 | N25-25-25.79 | E95-01-46.31 | 933             | Sowing from May to Jun., harvesting in<br>Oct.; making salad; immature fruit skin is<br>bicolor (white and green)  |
| MYC-22   | 270801 | 9                       | <i>Cucumis<br/>sativus</i> | Lu Ra      | Landrace          | Fruit               | Farmland        | Sagaing  | Khamti   | Layshi   | Lhan Lai Hla             | N25-26-27.86 | E95-03.25.22 | 752             | Received from "Makuri Naga" tribe<br>people; sowing in May, harvesting in Nov.;<br>making salad, stir frying with meet or other<br>vegetables  |
| MYC-23   | 270802 | 10                      | <i>Cucumis<br/>sativus</i> | Ygy        | Landrace          | Seed                | Farmland        | Sagaing  | Khamti   | Lashiy   | Daing Ka<br>Lain Away    | N25-28-10.37 | E94-57-05.34 | 1,315           | Received from "Para Naga" tribe people;<br>sowing from Apr. to Jul., harvesting from<br>Sep. to Oct.; eating green immature fruit  |
| MYC-24   | 270803 | 10                      | <i>Cucumis<br/>sativus</i> | Kgy        | Landrace          | Fruit               | Farmland        | Sagaing  | Khamti   | Layshi   | Daing Ka<br>Lain Sam Pya | N25-28-10.37 | E94-57-05.34 | 1,315           | Received from "Para Naga" tribe people;<br>sowing in Apr., harvesting in Oct.; making<br>salad   |

Collected samples with fruit state



Sample Photo 1.  
MYC-4 (*Momordica charantia*)



Sample Photo 2.  
MYC-5 (*Cucumis sativus*)



Sample Photo 3.  
MYC-8 (*Cucumis sativus*)



Sample Photo 4.  
MYC-9 (*Cucumis sativus*)



Sample Photo 5.  
MYC-10 (*Cucumis sativus*)



Sample Photo 6.  
MYC-11 (*Cucumis sativus*)



Sample Photo 7.  
MYC-12 (*Cucumis sativus*)



Sample Photo 8.  
MYC-13 (*Cucurbita moschata*)



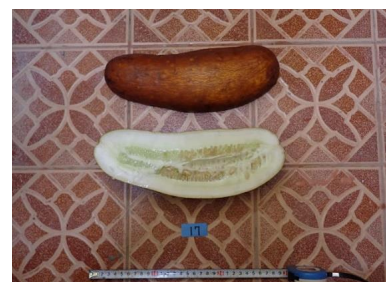
Sample Photo 9.  
MYC-14 (*Cucurbita moschata*)



Sample Photo 10.  
MYC-15 (*Cucurbita maxima*)



Sample Photo 11.  
MYC-16 (*Cucumis sativus*)



Sample Photo 12.  
MYC-17 (*Cucumis sativus*)

Collected samples with fruit state



Sample Photo 13.  
MYC-19 (*Cucumis sativus*)



Sample Photo 14.  
MYC-20 (*Cucumis sativus*)



Sample Photo 15.  
MYC-21 (*Cucumis sativus*)



Sample Photo 16.  
MYC-22 (*Cucumis sativus*)



Sample Photo 17.  
MYC-24 (*Cucumis sativus*)