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Original Paper

Collaborative Exploration of Amaranth Vegetable Germplasm in Cambodia, 2019

Ryoma TAKESHIMA [1)], Kazuhiro NEMOTO [2)], Leakhena MAT [3)], Dolla ROS [3)], Sreynech OUCH [3)], Sophany SAKHAN [3)], Makara OUK [3)]

1) *Institute of Crop Science, National Agriculture and Food Research Organization (NARO),* Kannondai 2-1-2, Tsukuba, Ibaraki 305-8518, Japan
2) *Graduate School of Agriculture, Shinshu University,* 8304 Minamiminowa, Nagano 399-4598, Japan
3) *Cambodian Agricultural Research and Development Institute*, National Road 3, Prateahlang Dangkor, P. O. Box 01, Phnom Penh, Cambodia

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Corresponding author: K. NEMOTO (e-mail: knemoto@shinshu-u.ac.jp)

Summary

This is a report for the Plant Genetic Resources in Asia project for the collaborative collection and conservation of plant genetic resources in east Cambodia under the agreement between the Cambodian Agricultural Research and Development Institute (CARDI) and the Genetic Resources Center, the National Agriculture and Food Research Organization (NARO), Japan. A field survey was conducted in five provinces (Kandal, Tboung Khmum, Kratie, Mondul Kiri, and Kompong Chan) in Cambodia from October 28 to November 8, 2019. We mainly focused on vegetable amaranths and collected a total of 75 germplasms, including 51 of amaranths (10 *Amaranthus blitum*, 20 *A. spinosus*, and 21 *A. viridis*), 19 of eggplants (*Solanum melongena*), 2 of turkey berries (*S. torvum*), 1 of *S. violaceum*, 1 of tomato (*Lycopersicon esculentum*), and 1 of *Trichosanthes cucumerina*. The seeds were divided equally: half were conserved in CARDI, and the other half was transferred to the gene bank at NARO.

KEY WORDS: amaranth, Cambodia, plant genetic resources, Solanaceae

Introduction

The collection of plant genetic resources is the basis for the development of food security, energy sources, animal feed, and fiber. To promote the development of these collections globally, the National Agriculture and Food Research Organization (NARO) in Japan and the Cambodian Agricultural Research and Development Institute (CARDI) established a Joint Research Agreement under the Plant Genetic Resources in Asia (PGRAsia Project) in July 2014.

Amaranthus is an important summer vegetable on home garden and commercial scales in Cambodia. The leaves of *Amaranthus* are rich sources of protein, carotenoid, vitamin C, and dietary fiber (Prakash and Pal 1991; Shukla *et al*. 2006; Ebert *et al.* 2011). In addition, *Amaranthus* has a high tolerance to heat and drought stress and can easily grow under various soil conditions (Katiyar *et al.* 2000; Shukla and Singh 2000; Zhu 2017). Owing to its high nutritional value and environmental adaptability, it has recently attracted attention as a new millennium crop (Rastogi and Shukla 2013). However, there has been no survey of vegetable amaranths under

the PGRAsia project in Cambodia. Here, we report the results of vegetable amaranth survey conducted in Cambodia from October 28 to November 8, 2019. We also collected few Solanaceae plants in this survey.

Methods

After preparation of exploration at CARDI on October 28, a field survey was conducted in Eastern Cambodia from October 29 to November 7 (Table 1). During the field survey, we collected germplasms from 47 villages belonging to five provinces (Fig. 1). We conducted a field survey from Phnom Penh and explored the Kandal, Tboung Khmum, Kratie, Mondul Kiri, and Kompong Chan provinces via a car. We collected vegetable germplasms from various locations such as farmers' houses, their backyards, local markets, and roadsides. As passport data, collection site (province, district, commune, and village), latitude, longitude, altitude, and local name of the plants were recorded. Latitude, longitude, and altitude were measured using Garmin eTrex 20x. Local names and related information of germplasms were obtained by interviewing farmers or sellers. The plant height of *Amaranthus* species were measured in the fields (Photo 1), except for B2, B4, B23,

Table 1. Itinerary of the field survey in Cambodia, 2019

Date (month/day)	Day	Itinerary	Stay
10/27	Sun	10:50 Narita airport -- 15:40 Phnom Penh International airport	Phnom Penh
10/28	Mon	visit CARDI -- (car) survey around Phnom Penh	Phnom Penh
10/29	Tue	Phnom Penh -- (car) -- Snuol	Snuol
10/30	Wed	Snuol-- (car) -- Sen Monoron	Sen Monoron
10/31	Thu	(car) survey around Sen Monoron	Sen Monoron
11/1	Fri	(car) survey around Sen Monoron	Sen Monoron
11/2	Sat	(car) survey around Sen Monoron	Sen Monoron
11/3	Sun	Sen Monoron-- (car) -- Kratie	Kratie
11/4	Mon	(car) survey around Kratie	Kratie
11/5	Tue	(car) survey around Kratie	Kratie
11/6	Wed	Kratie -- (car) -- Kampong Cham	Kampong Cham
11/7	Thu	Kampong Cham -- (car) -- Phnom Penh	Phnom Penh
11/8	Fri	visit CARDI -- Phnom Penh -- Phnom Penh International airport 22:50 --	on flight
11/9	Sat	-- 06:30 Narita airport	Tokyo

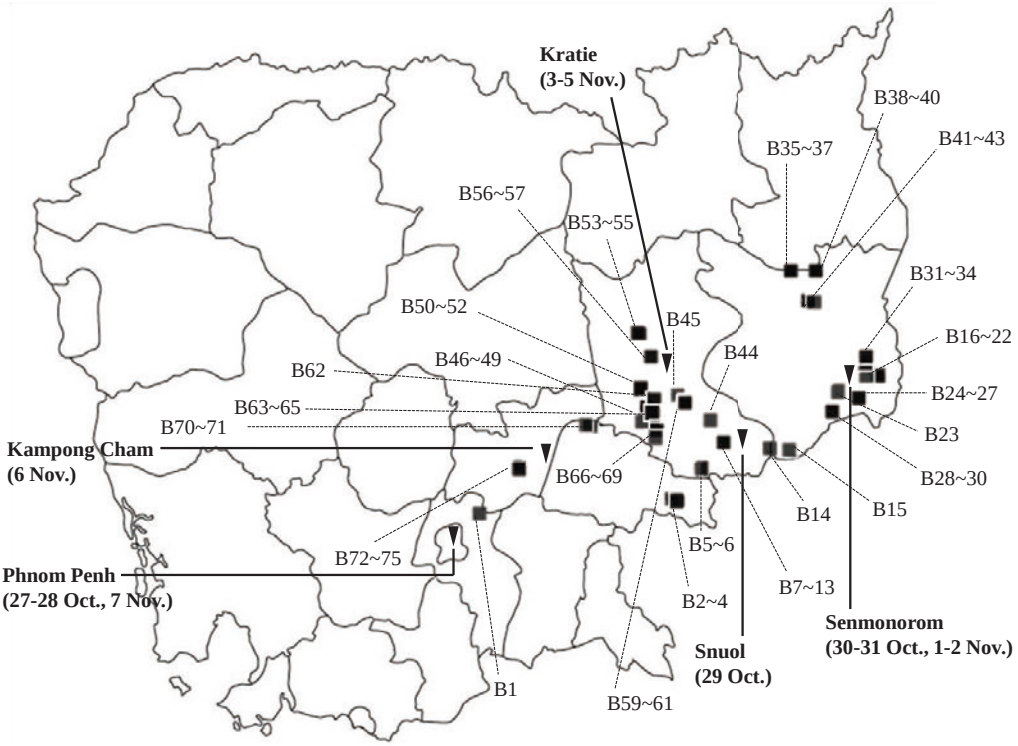

Fig. 1. Collection sites of each accession on Eastern Cambodia. Each collection site is indicated by a square with a corresponding accession numbers. Each stay site is indicated by a triangle.

Photo 1. The measured plant height in the field (Collection No. B31 [*Amaranthus viridis*]).

B29, B42, B71, and B74. Leaf area was measured using ImageJ (Schneider *et al*. 2012), except for B1, B2, B7, B12, B23, B28, B42, B55, B58, B66, B70, and B72.

Three Amaranthus species were identified based on the key characters as below.

A. blitum: Floral bracts, greenish, ovate, 33 %–50 % shorter than the perianth, acute, margin entire, glabrous. Staminate flowers with 3 tepals, ovate to lanceolate; 3 stamens. Pistillate flowers with 3 tepals, lanceolate or linear, elliptic to obovate or spatulate, with acute apex; 3 stigmas. Fruit reddish-brown to brown yellowish, sub-globose to ellipsoidal as long as or longer than the perianth smooth or slightly rugose, indehiscent (Walter and Dobeš 2004).

A. spinosus: Each node of stems with paired, divergent spines (modified bracts) measuring 1.5–2.5 cm. Bracts of pistillate flowers lanceolate to ovate-lanceolate, shorter than tepals, apex attenuations. Pistillate flowers: tepals 5, obovate-lanceolate or spatulate-lanceolate, equal or subequal, 1.2–2 mm, apex mucronate; styles erect or spreading; stigmas 3. Staminate flowers: often terminal or in proximal glomerulus; tepals 5, equal or subequal, 1.7–2.5 mm; stamens 5. Utricles ovoid to sub-globose, 1.5–2.5 mm, membranaceous proximally, wrinkled, spongy, or inflated distally, and irregularly dehiscent or indehiscent (Flora of North America Editorial Committee 2015).

A. viridis: Bracts deltoid- to lanceolate-ovate, membranous with a short awn from the green midrib. Perianth-segments 3, approximately 1.5-mm long. Stigmas 2–3. Capsule nearly globose, 1.25–1.75-mm long, not rupturing or rupturing irregularly, with rough surface (Townsend 1985).

Results and Discussion

In total, 75 germplasms were conserved in the gene bank at CARDI, Cambodia (Table 2). These germplasms included 51 of amaranths (10 *A. blitum*, 20 *A. spinosus*, and 21 *A. viridis*), 19 of eggplants (*Solanum melongena*), 2 of turkey berries (*S. torvum*), 1 of *S. violaceum*, 1 of tomato (*Lycopersicon esculentum*), and 1 of *Trichosanthes cucumerina*. The passport information of the collected materials is listed in Table 3. The seeds were divided equally: half were conserved in CARDI, and the other half was transferred to the gene bank at NARO.

Amaranths

We collected 51 vegetative amaranths (10 *A. blitum*, 20 *A. spinosus*, and 21 *A. viridis*). Amaranths were grown by most farmers who used the leaves and stems for food (Photos 2 and 3) as well as sold the leaves in the local market. There was a mix of two or three amaranth species on the same site, mostly a combination of *A. viridis* and *A. spinosus*, and the farmers recognized each as a different species. In addition, these species could be clearly distinguished by the difference in plant height and leaf area (Fig. 2).

Few farmers cultivated the second species because of their different leaf hardness and texture. In Cambodia, leaves are generally used as ingredients in soup. Many farmers seemed to prefer *A. viridis* over *A. spinosus*

Table 2. A summary of the collected genetic resources in Cambodia, 2019

Species	Total
Amaranthus blitum	10
Amaranthus spinosus	20
Amaranthus viridis	21
Lycopersicon esculentum	1
Solanum melongena	19
Solanum torvum	2
Solanum violaceum	1
Trichosanthes cucumerina	1
Total	75

Photo 2. Amaranth (*Amaranthus viridis*) cultivated in the backyards in Koh Nheak Dist, Mondul Kiri province.

Photo 3. Arrows indicated a harvest trace of *Amaranthus viridis.*

Photo 4. The local seed store in Phsa Memot village, Tboung Khmum province (Collection No. B2 [*Amaranthus viridis*]).

Photo 5. Amaranth (*Amaranthus viridis*) was sold as a leaf vegetable in a market in Chorm bork village, Mondul Kiri province.

Photo 6. Amaranth (*Amaranthus viridis*) was sold as a leaf vegetable in the market of Chorm bork village, Mondul Kiri province.

owing to their large leaves and less time and effort required for harvesting. However, some farmers stated that the taste of *A. spinosus* was better than that of *A. viridis*, although it was difficult to harvest because of the spines.

We could find vegetable amaranths (*A. viridis*) in the markets (Photos 4 to 6). Leaves were sold at 7,000 KHR (the riel, the currency of Cambodia) per kilogram. Seeds of *A. viridis* imported from Vietnam and Thailand were also sold in the market for 5,000 KHR per 50 g. The farmers were thought to use these seeds to produce leaves for selling.

In home gardens, amaranths were growing like weeds, but many farmers were actively involved in growing amaranths. In home gardens, we observed few matured plants left after harvesting leaves for seeds for the next season. One farmer harvested plants and put them at one place together to expect germination there from the seeds dropped. Another farmer collected seeds for the next season.

The feature of each collection is described below.

A. blitum

A. blitum plants could be observed at almost all survey sites, mainly outside houses, at the edge of fields, and beside roads, but the height of these plants was smaller than that of other species. We collected one sample from Kandal (B1), one sample from Kompong Chan (B73), five samples from Kratie (B8, B49, B57, B61, and B69), two samples from Mondul Kiri (B27 and B32), and one sample from Tboung Khmum (B71). *A. blitum* is called “Pty Arch Moan” in Kandal, Mondul Kiri, Kratie, Tboung Khmum, and Kompong Chan and “Pty Thmor” in Krati. “Pty” means amaranth, “Arch Moan” means chicken droppings, and “Thmor” means rock in Khmer. The range of plant height was 18.5–59.5 cm, and the median value was 40 cm. The range of leaf area was 4.6–35.6 cm^2, and the median value was 18.2 cm^2 (Fig. 2). The plant is not suitable for fresh consumption because of the relatively high levels of hydrocyanic acid and oxalic acid (Ebert *et al.* 2011).

A. spinosus

A. spinosus was observed everywhere at the survey sites, mainly in backyards and beside roads. We collected one sample from Kompong Chan (B72), eight from

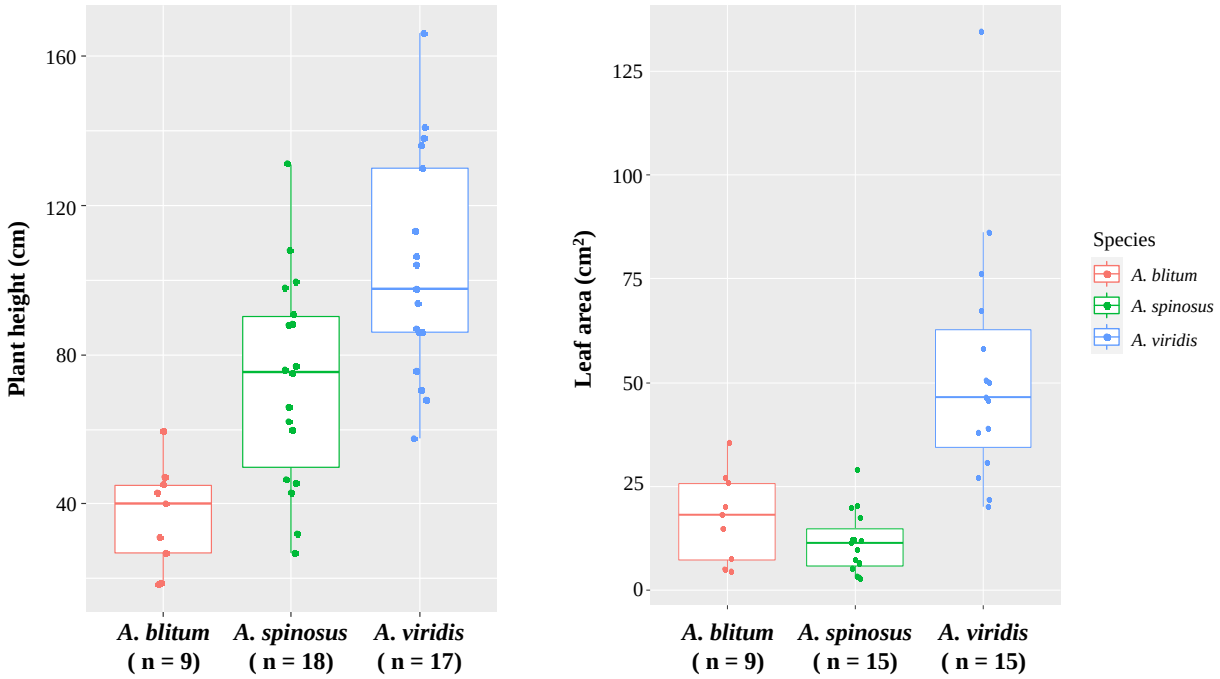

Fig. 2. Box plots of plant height and leaf area of Amaranth accessions.

Kratie (B5, B7, B45, B47, B52, B55, B58, and B68), nine from Mondul Kiri (B16, B21, B22, B26, B29, B34, B35, B38, and B41), and two from Tboung Khmum (B4 and B70). *A. spinosus* is called "Pty Bonla" in all provinces. "Bonla" means spine in Khmer. The range of plant height was 27‐131 cm, and the median value was 75.5 cm. The range of leaf area was 3.0‐29.2 cm^2, and the median value was 11.4 cm^2 (Fig. 2).

A. viridis

Similar to *A. spinosus, A. viridis* was also observed at all survey sites, mainly in backyards. We collected two samples from Kompong Chan (B74 and B75), nine from Kratie (B6, B12, B14, B44, B46, B51, B53, B56, and B66), eight from Mondul Kiri (B17, B23, B28, B31, B33, B36, B39, and B42), and two from Tboung Khmum (B2 and B3). *A. viridis* was called "Pty Dong" in Tboung Khmum, Kratie, Mondul Kiri, and Kompong Chan. "Dong" means coconut fruit in Khmer. The range of plant height was 57.5‐166 cm, and the median value was 97.5 cm. The range of leaf area was 20.0‐134.7 cm^2, and the median value was 46.6 cm^2 (Fig. 2).

Under the PGRAsia Project in Cambodia, four samples of amaranths genetic resources have been collected till date, and two species of *A. blitum* and *A. cruentus* have been identified (Kondo *et al.* 2019; Matsushima *et al.* 2018). In this exploration, we could collect 51 cohesive samples of amaranth genetic resources and add two new species, *A. spinosus* and *A. viridis*. In contrast, in neighboring Vietnam, a total of 90 samples of amaranth genetic resources have been collected (Kawazu *et al*. 2017; Shimomura *et al.* 2016; Fujito *et al.* 2018; Kami *et al.* 2019). Although these samples have not been clearly identified, the composition and utilization of the species were considered similar to those from Cambodia, as determined from the text and photographs of references.

Solanaceae

We collected 19 eggplants (*S. melongena*), 2 turkey berries (*S. torvum*), 1 *S. violaceum*, 1 tomato (*Lycopersicon esculentum*), and 1 *Trichosanthes cucumerina*.

S. melongena

Ten samples were collected from Kratie (B9, B10, B13, B50, B59, B62, B63, B64, B65, and B67) and nine samples from Mondul Kiri (B18, B19, B20, B24, B25, B30, B37, B40, and B43). *S. melongena* is called "Trob," "Trub Svay," "Trub Sroy," "Trub Sor," "Troup srouy," or "Troup Chou" in Kratie and "Trub Plen," "Trub Plen Tapea," "Peang Pors Pream Prem," "Trub Plan Ka," "Trub Srav," "Trub Kdor Kao," "Trub Ropeak," or "Trob" in Mondul Kiri. Eggplant accessions had various fruit colors, including purple (B9), green (B10), yellow (B19, B24, B40, B50, B59, and B62), and white (B13). The fruit shapes were round (B9, B10, B13, B24, B25, B30, B40, B43, B50, B59, and B62), egg-shaped (B18 and B19), or long (B37). Some farmers stuck sticks into the fruit to store seeds (B18 and B19).

S. torvum

We collected two *S. torvum* strains from Kratie (B48 and B54). *S. trovum* is called "Troup Nhorng" or "Troup pot Nhorng" in Kratie and had lobed leaf margins and white flowers. It was grown in kitchen gardens, and the fruits were consumed in soup.

S. violaceum

We collected one *S. violaceum* sample from Kratie (B60). It was called "Troup Pot Nhorng" in Kratie. *S. violaceum* had a deeply lobed leaf margin and light purple flower. Like *S. torvum*, it was grown in kitchen gardens, and its fruits were consumed in soup.

L. esculentum

We collected one *L. esculentum* from Mondul Kiri (B15), where it was called "Trub Kilo." According to the farmer who grew this sample, many tomato varieties have already been replaced by F_1 varieties in this area, but this sample has been maintained by self-seeding for a long time.

Cucurbitaceae

We collected one *Trichosanthes cucumerina* sample.

T. cucumerina

We collected one *T. cucumerina* sample from Kratie (B11), which it is called "Nor norng Tes." This sample was not a commercial variety and was maintained by self-seeding.

Acknowledgements

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References

Ebert AW, Wu T and Wang S (2011) International Cooperators' Guide: Vegetable amaranth (*Amaranthus* L.). AVRDC - The World Vegetable Center: Taiwan, pp. 1-9 (AVRDC Publication Number: 11-754).

Flora of North America Editorial Committee (2015) Flora of North America North of Mexico, Oxford University Press, New York.

Fujito S, Shimomura K, Tran TTH and Nguyen VK (2018) Collaborative exploration of the vegetable genetic resources in Vietnam, 2017. AREIPGR 34: 228-244.
[View this article]

Kami D, Mitsudome K, Tran TTH and Nguyen VK (2019) Collaborative exploration of plant genetic resources in the central highlands of Vietnam, 2018. AREIPGR 35: 56-70.
[View this article]

Katiyar RS, Shukla S and Rai S (2000) Varietal performance of grain amaranths (*A. hypochondriacus*) on sodic soil. Proc Natl Acad Sci India Sect B Biol Sci 70: 185-187.

Kawazu Y, Kato M, Tran TTH and Nguyen VK (2017) Collaborative exploration of plant genetic resources in Vietnam, 2016. AREIPGR 33: 89-113.
[View this article]

Kondo F, Layheng S, Tokuda M, Rathnayaka RMSMB, Sophany S and Matsushima K (2019) Collaborative exploration of plant genetic resources in northern Cambodia, 2018. AREIPGR 35: 162-184.
[View this article]

Matsushima K, Layheng S, Hatakeyama K, Kurumada S and Sophany S (2018) Collaborative exploration of plant genetic resources in eastern Cambodia, 2017. AREIPGR 34: 118-136.
[View this article]

Prakash D and Pal M (1991) Nutritional and antinutritional composition of vegetable and grain amaranth leaves. J Sci Food Agric 57: 573-583. [https://doi.org/10.1002/jsfa.2740570410]

Rastogi A and Shukla S (2013) Amaranth: A new millennium crop of nutraceutical values. Crit Rev Food Sci Nutr 53: 109-125. [https://doi.org/10.1080/10408398.2010.517876]

Schneider CA, Rasband WS and Eliceiri KW (2012) NIH Image to ImageJ: 25 years of image analysis. Nat Methods 9: 671-675. [https://doi.org/10.1038/nmeth.2089]

Shimomura K, Sugiyama K, Yoshioka Y, Tran TTH and Nguyen VK (2016) Collaborative exploration of plant genetic resources in Vietnam, 2015. AREIPGR 32: 159-181.
[View this article]

Shukla S, Bhargava A, Chatterjee A, Srivastava A and Singh SP (2006) Genotypic variability in vegetable amaranth (*Amaranthus tricolor* L) for foliage yield and its contributing traits over successive cuttings and years. Euphytica 151: 103-110. [https://doi.org/10.1007/s10681-006-9134-3]

Shukla S and Singh SP (2000) Studies on genetic parameters in vegetable amaranth. J Genet Breed 54: 133-135.

Townsend CC (1985) Amaranthaceae. *In*: Flora of tropical east Africa. Polhill RM (ed.). A. A. Balkema: Rotterdam, Netherlands, pp. 1-2, pp. 20-24, pp. 35-36.

Walter J and Dobeš C (2004) Morphological characters, geographic distribution, and ecology of neophytic *Amaranthus blitum* L. subsp. *emarginatus* in Austria. Ann Naturhist Mus Wien 105: 645-672.

Zhu F (2017) Structures, physicochemical properties, and applications of amaranth starch. Crit Rev Food Sci Nutr 57: 313-325. [https://doi.org/10.1080/10408398.2013.862784]

2019 年カンボジアにおける
葉菜用アマランサス遺伝資源の共同探索

竹島 亮馬 [1)]・根本 和洋 [2)]・Leakhena MAT [3)]・Dolla ROS [3)]・
Sreynech OUCH [3)]・Sophany SAKHAN [3)]・Makara OUK [3)]

1) 農業・食品産業技術総合研究機構 次世代作物開発研究センター
2) 信州大学 農学部
3) カンボジア農業開発研究所

和文摘要

本報告は Plant Genetic Resources in Asia プロジェクトのもと，国立研究開発法人農業・食品産業技術総合研究機構（農研機構）（NARO）とカンボジア農業開発研究所（CARDI）とで行った東カンボジア地域における植物遺伝資源の共同探索および収集に関する報告書である．2019 年 10 月 28 日から 11 月 8 日にカンボジア東部の 5 つの州 (カンダル州，トボンクムン州，クラチエ州，モンドルキリ州，コンポンチャム州) において現地調査を実施した．葉菜用アマランサスを中心に合計 75 点収集し，葉菜用アマランサスが 51 点 (*Amaranthus blitum* 10 点，*A. spinosus* 20 点，*A. viridis* 21 点)，ナス (*Solanum melongena*) が 19 点，スズメナスビ (*S. torvum*) が 2 点，*S. violaceum* が 1 点，トマト (*Lycopersicon esculentum*) が 1 点，ヘビウリ (*Trichosanthes cucumerina*) が 1 点であった．収集した遺伝資源の種子は 2 等分し，NARO のジーンバンクと CARDI にそれぞれ移送され，保存された．

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

No.	Coll. No.	JP No.	Coll. Date	Species	Local Name	Province	District	Commune	Village	Tribe	North Latitude	East Longtitude	Altitude (m)
1	B1	271689	29, Oct 2019	*Amaranthus blitum* L.	Pty Arch Moan	Kandal	Ksarch Karndal	Mlou	Prek Ta Mak	Khmer	11.737756	105.026111	17
2	B2	271690	29, Oct 2019	*Amaranthus viridis* L.	Pty Sor	Tboung Khmum	Memot	Memot	Phsa Memot	Khmer	11.827756	106.181211	58
3	B3	271691	29, Oct 2019	*Amaranthus viridis* L.	Pty Dong	Tboung Khmum	Memot	Kromuong	Raong Chakskor	Khmer	11.813289	106.212067	115
4	B4	271692	29, Oct 2019	*Amaranthus spinosus* L.	Pty Bonla	Tboung Khmum	Memot	Kromuong	Raong Chakskor	Khmer	11.813289	106.212067	115
5	B5	271693	29, Oct 2019	*Amaranthus spinosus* L.	Pty Bonla	Kratie	Snoul	Srae char	Kbal trach	Khmer	12.012564	106.398583	73
6	B6	271694	29, Oct 2019	*Amaranthus viridis* L.	Pty Dong	Kratie	Snoul	Srae char	Doun Meas	Khmer	12.004556	106.358439	73
7	B7	271695	30, Oct 2019	*Amaranthus spinosus* L.	Pty Bonla	Kratie	Snoul	Khsuem	Khsuem krav	Khmer	12.171067	106.453336	66
8	B8	271696	30, Oct 2019	*Amaranthus blitum* L.	Pty Arch Moan	Kratie	Snoul	Khsuem	Khsuem krav	Khmer	12.170686	106.458253	68
9	B9	271697	30, Oct 2019	*Solanum melongena* L.	Trub Svay	Kratie	Snoul	Khsuem	Khsuem khnong	Khmer	12.172492	106.481631	74
10	B10	271698	30, Oct 2019	*Solanum melongena* L.	Trub Sroy	Kratie	Snoul	Khsuem	Khsuem khnong	Khmer	12.172492	106.481631	74
11	B11	271699	30, Oct 2019	*Trichosanthes cucumerina* L.	Nor norng Tes	Kratie	Snoul	Khsuem	Khsuem khnong	Khmer	12.172492	106.481631	74
12	B12	271700	30, Oct 2019	*Amaranthus viridis* L.	Pty Dong	Kratie	Snoul	Khsuem	Khsuem khnong	Khmer	12.160811	106.49035	91
13	B13	271701	30, Oct 2019	*Solanum melongena* L.	Trub Sor	Kratie	Snoul	Khsuem	Khsuem khnong	Khmer	12.160811	106.49035	91
14	B14	271702	30, Oct 2019	*Amaranthus viridis* L.	Pty Dong	Kratie	Snoul	Kabey	Kro Nhoung Sen Chey	Islam	12.125403	106.7768	122
15	B15	271703	30, Oct 2019	*Lycopersicon esculentum* Mill.	Trub Kilo	Mondul Kiri	Keo seima	Ba Khae	Ou Arm	Islam	12.114208	106.893025	128
16	B16	271704	31, Oct 2019	*Amaranthus spinosus* L.	Pty Bonla	Mondul Kiri	Pechreda	Bousra	Pou lu	Phnong	12.528919	107.42995	535
17	B17	271705	31, Oct 2019	*Amaranthus viridis* L.	Pty Dong	Mondul Kiri	Pechreda	Bousra	Pou lu	Phnong	12.528669	107.430217	530
18	B18	271706	31, Oct 2019	*Solanum melongena* L.	Trub Plen	Mondul Kiri	Pechreda	Bousra	La mes	Phnong	12.531853	107.429981	527
19	B19	271707	31, Oct 2019	*Solanum melongena* L.	Trub Plen Tapea	Mondul Kiri	Pechreda	Bousra	Pureng	Phnong	12.5407	107.431067	532
20	B20	271708	31, Oct 2019	*Solanum melongena* L.	Peang Pors Pream Prem	Mondul Kiri	Pechreda	Bousra	Pou rang	Phnong	12.5407	107.431067	532
21	B21	271709	31, Oct 2019	*Amaranthus spinosus* L.	Pty Bonla	Mondul Kiri	Pechreda	Bousra	Pou teul	Phnong	12.552339	107.422592	521
22	B22	271710	31, Oct 2019	*Amaranthus spinosus* L.	Pty Bonla	Mondul Kiri	Pechreda	Srae Ampoum	Pou radeat	Khmer	12.551464	107.355133	460
23	B23	271711	1, Nov 2019	*Amaranthus viridis* L.	Pty Dong	Mondul Kiri	Pechreda	Spean Mean Chey	Chorm bork	Phnong	12.457942	107.184331	698
24	B24	271712	1, Nov 2019	*Solanum melongena* L.	Trub Plan Ka	Mondul Kiri	Pechreda	Dak dam	Pou chhorb	Phnong	12.421919	107.298044	866
25	B25	271713	1, Nov 2019	*Solanum melongena* L.	Trub Srav	Mondul Kiri	Pechreda	Dak dam	Pou chhorb	Phnong	12.421919	107.298044	866
26	B26	271714	1, Nov 2019	*Amaranthus spinosus* L.	Pty Bonla	Mondul Kiri	Pechreda	Dak dam	Pou les	Phnong	12.418914	107.312344	831
27	B27	271715	1, Nov 2019	*Amaranthus blitum* L.	Pty Arch Moan	Mondul Kiri	Pechreda	Dak dam	Pou les	Phnong	12.418914	107.312344	831
28	B28	271716	1, Nov 2019	*Amaranthus viridis* L.	Pty Dong	Mondul Kiri	Pechreda	Sen Monorom	Pou shiam	Phnong	12.33955	107.147419	734
29	B29	271717	1, Nov 2019	*Amaranthus spinosus* L.	Pty Bonla	Mondul Kiri	Pechreda	Sen Monorom	Pou shiam	Phnong	12.33955	107.147419	734
30	B30	271718	1, Nov 2019	*Solanum melongena* L.	Trub Srav	Mondul Kiri	Pechreda	Sen Monorom	Pou shiam	Phnong	12.33955	107.147419	734
31	B31	271719	1, Nov 2019	*Amaranthus viridis* L.	Pty Dong	Mondul Kiri	Pechreda	Krang Tes	Krang Tes	Phnong	12.623086	107.348542	458
32	B32	271720	1, Nov 2019	*Amaranthus blitum* L.	Pty Arch Moan	Mondul Kiri	Pechreda	Krang Tes	Krang Tes	Phnong	12.622714	107.3491	460
33	B33	271721	1, Nov 2019	*Amaranthus viridis* L.	Pty Dong	Mondul Kiri	Pechreda	Krang Tes	Tram Karch	Phnong	12.659731	107.352067	453
34	B34	271722	1, Nov 2019	*Amaranthus spinosus* L.	Pty Bonla	Mondul Kiri	Pechreda	Krang Tes	Pou Ropet	Phnong	12.665567	107.354047	450
35	B35	271723	2, Nov 2019	*Amaranthus spinosus* L.	Pty Bonla	Mondul Kiri	Koh Nheak	Royor	Rovak	Kroal	13.162575	106.901747	142
36	B36	271724	2, Nov 2019	*Amaranthus viridis* L.	Pty Dong	Mondul Kiri	Koh Nheak	Royor	Rovak	Kroal	13.162575	106.901747	142
37	B37	271725	2, Nov 2019	*Solanum melongena* L.	Trub Kdor Kao	Mondul Kiri	Koh Nheak	Royor	Rovak	Kroal	13.162575	106.901747	142
38	B38	271726	2, Nov 2019	*Amaranthus spinosus* L.	Pty Bonla	Mondul Kiri	Koh Nheak	Royor	Royor Krom	Kroal	13.156408	107.051139	127

Table 3. (Continued).

No.	Coll. No.	JP No.	Coll. Date	Species	Local Name	Province	District	Commune	Village	Tribe	North Latitude	East Longtitude	Altitude (m)
39	B39	271727	2, Nov 2019	*Amaranthus viridis* L.	Pty Dong	Mondul Kiri	Koh Nheak	Royor	Royor Krom	Kroal	13.156408	107.051139	127
40	B40	271728	2, Nov 2019	*Solanum melongena* L.	Trub Ropeak	Mondul Kiri	Koh Nheak	Royor	Royor Krom	Kroal	13.166989	107.052253	121
41	B41	271729	2, Nov 2019	*Amaranthus spinosus* L.	Pty Bonla	Mondul Kiri	Koh Nheak	Sok San	Chi Klorb	Phnong	12.988372	107.00715	144
42	B42	271730	2, Nov 2019	*Amaranthus viridis* L.	Pty Dong	Mondul Kiri	Koh Nheak	Sok San	Chi Klorb	Phnong	12.988372	107.00715	144
43	B43	271731	2, Nov 2019	*Solanum melongena* L.	Trob	Mondul Kiri	Koh Nheak	Sok San	Klong Lae	Phnong	12.984425	107.0389	149
44	B44	271732	3, Nov 2019	*Amaranthus viridis* L.	Pty Dong	Kratie	Snoul	Khsuem	Srae Roneam	Khmer	12.287903	106.414289	74
45	B45	271733	3, Nov 2019	*Amaranthus spinosus* L.	Pty Bonla	Kratie	Chet Bourey	Kon tout	Ang krong	Khmer	12.437314	106.221489	42
46	B46	271734	4, Nov 2019	*Amaranthus viridis* L.	Pty Dong	Kratie	Prek Pro Sorb	Prek Pro Sorb	Prek Pro Sorb Leu	Khmer	12.364747	106.018033	22
47	B47	271735	4, Nov 2019	*Amaranthus spinosus* L.	Pty Bonla	Kratie	Prek Pro Sorb	Prek Pro Sorb	Prek Pro Sorb Leu	Khmer	12.364747	106.018033	22
48	B48	271736	4, Nov 2019	*Solanum torvum* Swartz.	Troup Nhorng	Kratie	Prek Pro Sorb	Prek Pro Sorb	Prek Pro Sorb Leu	Khmer	12.363581	106.028853	23
49	B49	271737	4, Nov 2019	*Amaranthus blitum* L.	Pty Thmor	Kratie	Prek Pro Sorb	Kom Pong Kou	Sneng Krobey	Khmer	12.281689	106.003125	23
50	B50	271738	4, Nov 2019	*Solanum melongena* L.	Troup Srouy	Kratie	Prek Pro Sorb	Psorb Krom	Psorb Krom	Khmer	12.474703	105.997142	23
51	B51	271739	4, Nov 2019	*Amaranthus viridis* L.	Pty Dong	Kratie	Prek Pro Sorb	Psorb Krom	Psorb Krom	Khmer	12.474703	105.997142	23
52	B52	271740	4, Nov 2019	*Amaranthus spinosus* L.	Pty Bonla	Kratie	Prek Pro Sorb	Psorb Krom	Psorb Krom	Khmer	12.474703	105.997142	23
53	B53	271741	5, Nov 2019	*Amaranthus viridis* L.	Pty Dong	Kratie	Som Bou	Som Bou	Som Bou	Khmer	12.784825	105.967506	31
54	B54	271742	5, Nov 2019	*Solanum torvum* Swartz.	Troup pot Nhorng	Kratie	Som Bou	Koh Knhae	Sray Chek	Khmer	12.802975	105.981422	28
55	B55	271743	5, Nov 2019	*Amaranthus spinosus* L.	Pty Bonla	Kratie	Som Bou	Koh Knhae	Sray Chek	Khmer	12.802975	105.981422	28
56	B56	271744	5, Nov 2019	*Amaranthus viridis* L.	Pty Dong	Kratie	Chen Borey	Som Bou	Srae Ta Haen	Khmer	12.662128	106.058714	37
57	B57	271745	5, Nov 2019	*Amaranthus blitum* L.	Pty Thmor	Kratie	Chen Borey	Som Bou	Srae Ta Haen	Khmer	12.662128	106.058714	37
58	B58	271746	5, Nov 2019	*Amaranthus spinosus* L.	Pty Bonla	Kratie	Chen Borey	Korn Tout	Srae Nhoun	Khmer	12.393247	106.263581	34
59	B59	271747	5, Nov 2019	*Solanum melongena* L.	Troup Srouy	Kratie	Chen Borey	Korn Tout	Srae Nhoun	Khmer	12.393247	106.263581	34
60	B60	271748	5, Nov 2019	*Solanum violaceum* Ortega	Troup Pot Nhorng	Kratie	Chen Borey	Korn Tout	Srae Nhoun	Khmer	12.393247	106.263581	34
61	B61	271749	5, Nov 2019	*Amaranthus blitum* L.	Pty Thmor	Kratie	Chet Borey	Bous Leav	Praek Kouv	Khmer	12.412681	106.075508	27
62	B62	271750	5, Nov 2019	*Solanum melongena* L.	Troup srouy	Kratie	Chet Borey	Bous Leav	Praek Kouv	Khmer	12.412681	106.075508	27
63	B63	271751	6, Nov 2019	*Solanum melongena* L.	Trob	Kratie	Chhlong	Kanh Chour	Praek Chom Lak	Khmer	12.331794	106.062589	31
64	B64	271752	6, Nov 2019	*Solanum melongena* L.	Trob	Kratie	Chhlong	Kanh Chour	Praek Chom Lak	Khmer	12.331794	106.062589	31
65	B65	271753	6, Nov 2019	*Solanum melongena* L.	Trob	Kratie	Chhlong	Kanh Chour	Praek Chom Lak	Khmer	12.331794	106.062589	31
66	B66	271754	6, Nov 2019	*Amaranthus viridis* L.	Pty Dong	Kratie	Chhlong	Dom Rie Poung	Pro Lay Tri	Khmer	12.244586	106.096639	53
67	B67	271755	6, Nov 2019	*Solanum melongena* L.	Troup Chou	Kratie	Chhlong	Dom Rie Poung	Pro Lay Tri	Khmer	12.244586	106.096639	53
68	B68	271756	6, Nov 2019	*Amaranthus spinosus* L.	Pty Bonla	Kratie	Chhlong	Dom Rie Poung	Pro Lay Tri	Khmer	12.227736	106.094425	40
69	B69	271757	6, Nov 2019	*Amaranthus blitum* L.	Pty Arch Moan	Kratie	Chhlong	Dom Rie Poung	Pro Hout	Khmer	12.187361	106.082517	32
70	B70	271758	6, Nov 2019	*Amaranthus spinosus* L.	Pty Bonla	Tboung Khmum	Kroch Chhmar	Por Py	Die Dose	Khmer	12.252483	105.693156	21
71	B71	271759	6, Nov 2019	*Amaranthus blitum* L.	Pty Arch Moan	Tboung Khmum	Kroch Chhmar	Svay Klaeng	Poum Ti Bey	Khmer	12.262086	105.664067	15
72	B72	271760	7, Nov 2019	*Amaranthus spinosus* L.	Pty Bonla	Kompong Chan	Prey Chhor	Chrie van	Tikh Nim	Khmer	12.030975	105.247947	23
73	B73	271761	7, Nov 2019	*Amaranthus blitum* L.	Pty Arch Moan	Kompong Chan	Prey Chhor	Chrie van	Tikh Nim	Khmer	12.030975	105.247947	23
74	B74	271762	7, Nov 2019	*Amaranthus viridis* L.	Pty Dong	Kompong Chan	Korng Meas	Prek kro Bao	Ou Kondol	Khmer	12.004592	105.266192	13
75	B75	271763	7, Nov 2019	*Amaranthus viridis* L.	Pty Thmor	Kompong Chan	Korng Meas	Prek kro Bao	Ou Kondol	Khmer	12.004592	105.266192	13

Sample Photos

Sample Photo 1.
B1. *Amaranthus blitum*

Sample Photo 2.
B2. *Amaranthus viridis*

Sample Photo 3.
B3. *Amaranthus viridis*

Sample Photo 4.
B4. *Amaranthus spinosus*

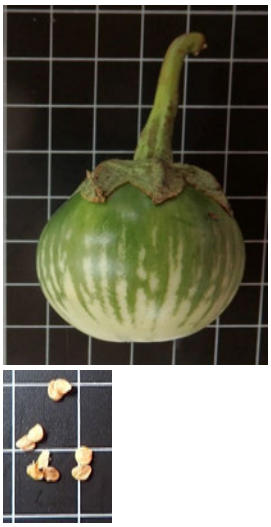
Sample Photo 5.
B5. *Amaranthus spinosus*

Sample Photo 6.
B6. *Amaranthus viridis*

Sample Photo 7.
B7. *Amaranthus spinosus*

Sample Photo 8.
B8. *Amaranthus blitum*

Sample Photo 9.
B9. *Solanum melongena*



Sample Photo 10.
B10. *Solanum melongena*

Sample Photo 11.
B11. *Trichosanthes cucumerina*

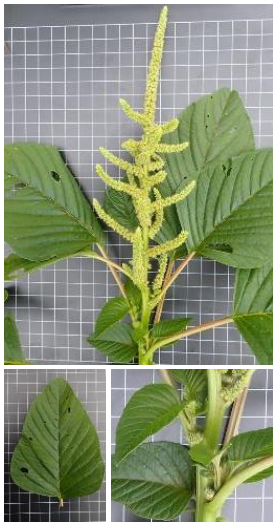
Sample Photo 12.
B12. *Amaranthus viridis*

Sample Photos

Sample Photo 13.
B13. *Solanum melongena*

Sample Photo 14.
B14. *Amaranthus viridis*

Sample Photo 15.
B16. *Amaranthus spinosus*



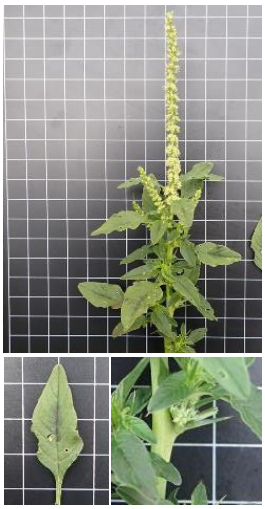
Sample Photo 16.
B17. *Amaranthus viridis*

Sample Photo 17.
B18. *Solanum melongena*

Sample Photo 18.
B19. *Solanum melongena*

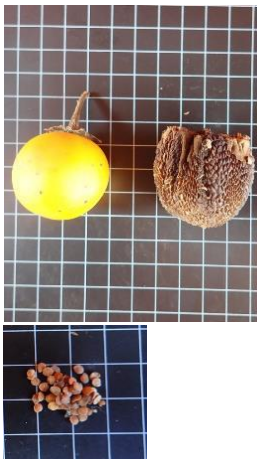
Sample Photo 19.
B20. *Solanum melongena*

Sample Photo 20.
B21. *Amaranthus spinosus*



Sample Photo 21.
B22. *Amaranthus spinosus*

Sample Photo 22.
B23. *Amaranthus viridis*



Sample Photo 23.
B24. *Solanum melongena*

Sample Photo 24.
B25. *Solanum melongena*

Sample Photos

Sample Photo 25.
B26. *Amaranthus spinosus*

Sample Photo 26.
B27. *Amaranthus blitum*

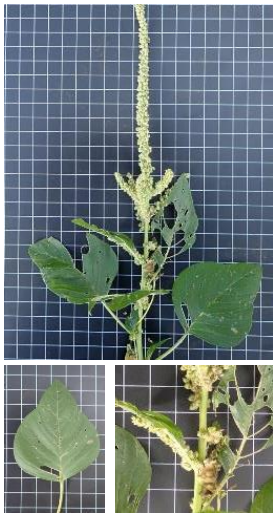
Sample Photo 27.
B28. *Amaranthus viridis*

Sample Photo 28.
B29. *Amaranthus spinosus*

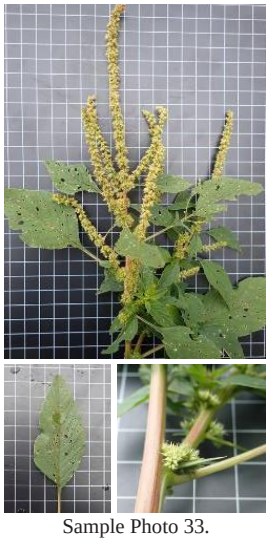
Sample Photo 29.
B30. *Solanum melongena*

Sample Photo 30.
B31. *Amaranthus viridis*

Sample Photo 31.
B32. *Amaranthus blitum*



Sample Photo 32.
B33. *Amaranthus viridis*



Sample Photo 33.
B34. *Amaranthus spinosus*

Sample Photo 34.
B35. *Amaranthus spinosus*

Sample Photo 35.
B36. *Amaranthus viridis*

Sample Photo 36.
B37. *Solanum melongena*

Sample Photos

Sample Photo 37.
B38. *Amaranthus spinosus*

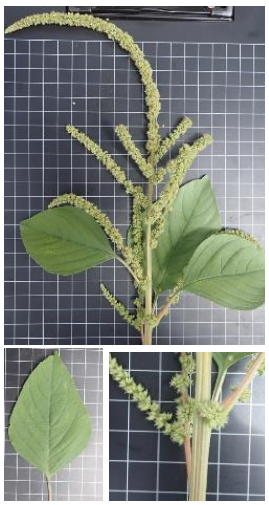
Sample Photo 38.
B39. *Amaranthus viridis*

Sample Photo 39.
B40. *Solanum melongena*

Sample Photo 40.
B41. *Amaranthus spinosus*

Sample Photo 41.
B42. *Amaranthus viridis*

Sample Photo 42.
B43. *Solanum melongena*



Sample Photo 43.
B44. *Amaranthus viridis*

Sample Photo 44.
B45. *Amaranthus spinosus*

Sample Photo 45.
B46. *Amaranthus viridis*

Sample Photo 46.
B47. *Amaranthus spinosus*

Sample Photo 47.
B48. *Solanum torvum*

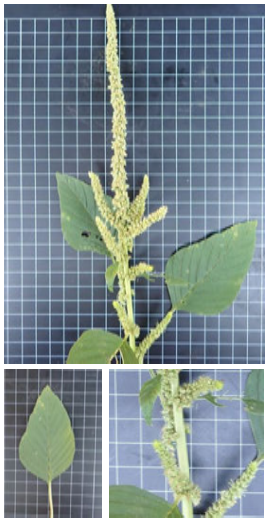
Sample Photo 48.
B49. *Amaranthus blitum*

Sample Photos

Sample Photo 49.
B50. *Solanum melongena*

Sample Photo 50.
B51. *Amaranthus viridis*

Sample Photo 51.
B52. *Amaranthus spinosus*



Sample Photo 52.
B53. *Amaranthus viridis*

Sample Photo 53.
B54. *Solanum torvum*

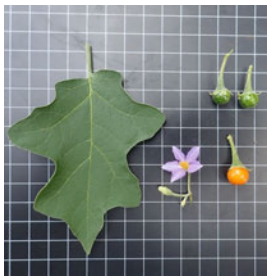
Sample Photo 54.
B55. *Amaranthus spinosus*

Sample Photo 55.
B56. *Amaranthus viridis*

Sample Photo 56.
B57. *Amaranthus blitum*

Sample Photo 57.
B58. *Amaranthus spinosus*

Sample Photo 58.
B59. *Solanum melongena*



Sample Photo 59.
B60. *Solanum violaceum*

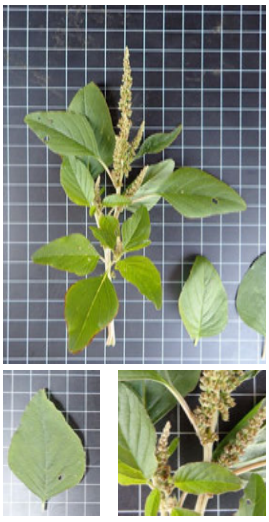
Sample Photo 60.
B61. *Amaranthus blitum*

Sample Photos

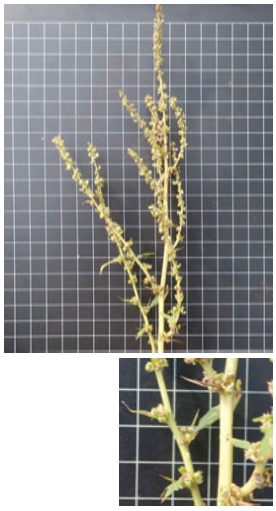
Sample Photo 61.
B62. *Solanum melongena*

Sample Photo 62.
B66. *Amaranthus viridis*

Sample Photo 63.
B68. *Amaranthus spinosus*

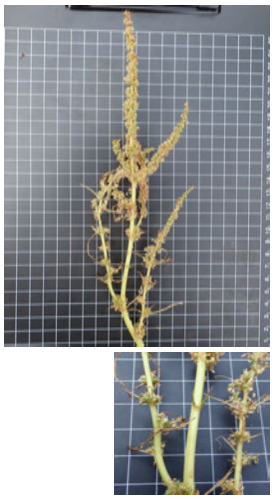


Sample Photo 64.
B69. *Amaranthus blitum*



Sample Photo 65.
B70. *Amaranthus spinosus*

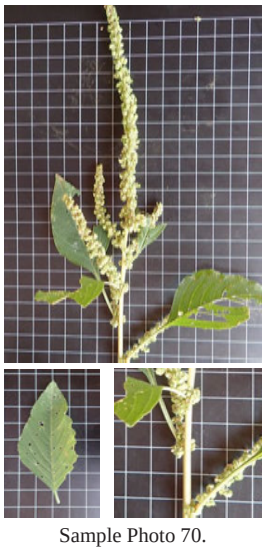
Sample Photo 66.
B71. *Amaranthus blitum*



Sample Photo 67.
B72. *Amaranthus spinosus*

Sample Photo 68.
B73. *Amaranthus blitum*

Sample Photo 69.
B74. *Amaranthus viridis*



Sample Photo 70.
B75. *Amaranthus viridis*