Psych Educ, Document ID: 2022PEMJ0, doi: 10.5281/zenodo.7112059, ISSN 2822-4353

Research Article

Thigmotropism in Vigna Unguiculata Subsp. Sesquipedalis (c.n Sitaw)

Rowena K. Zainudin*, Haron A. Mohamad, Datu Raffy Ralph S. Sinsuat
For affiliations and correspondence, see the last page.

Abstract

The study entitled THIGMOTROPISM IN *Vigna unguiculata subsp. Sesquipedalis* (c.n SITAW). *determines* the age of the plants when their vines start to form, the significant differences between and among the treatment means in terms of distance per twining, number of twining and the direction of twining of the plant. The sitaw seeds were planted on the plot having different diameter of pole (T_1, T_2, and T_3) to support their vines. The changes were monitored every 24 hours. The result shows that the age of the plants when their vines tips begin to appear is mostly seen between 23rd to 26th day. There is no significant difference between the treatment with pole diameter of T_1 and T_2, and there is significant difference between and among the treatment pole diameter T_1 and T_3, T_2 and T_3 in terms of distance per twining. There is no significant difference between the treatment with pole diameter T_1 and T_2, however, there is a significant difference between treatment pole diameter T_1 and T_3, T_2 and T_3 in terms of number of twines per vine. The direction of twining is counter clock wise for all the plant plots with pole diameter T_1, T_2, and T_3.

Keywords: Thigmotropism, Vigna Unguiculata Subsp., Sesquipedalis, Sitaw

Introduction

Plants are thought to be mostly stationary, according to popular belief. Plants, on the other hand, goes through several stages, that can be rather rapid, such as carnivore plants closing trap, leguminosae varieties folded up leaves, and floral parts working to improve cross pollination. It is uncommon to see plants move through their own while observing them. They look to be stationary, with rigid constructions anchored to the ground. Quick plant reactions (especially those to mechanical stimuli) are often the result of the natural selecting driven by changes in the environment that force plants to respond rapidly. Plants migrate to grow around objects that provide constant direct stress, such as a trellis; this is called thigmotropism (Scorza 2011).

Thigmotropism is the growth of a plant as a result of contact with an item. Positive thigmostropism is found in vertical gardens or vines with tendrils. A vine is a spiraling appendage that twines around solid objects. A vine is a plant that has twisted leaves, stems, or petioles. A vine grows in a circular arrangement. As the tip bends in different directions, spiral and asymmetrical circles develop. The motion of the growing vine resembles that of a plant seeking contact. When the vine comes in contact with an object, sensors epidermis cells on its surface are triggered. These cells tell the vine how to wrap around the target. Vine twinning is caused by differentiating growth (Bailey 2018).

V. unguiculata (c.n Sitaw) is a valuable leguminous crop. The popular term for it is vegetable cowpea. It's a cowpea variety grown for its extremely tall (35 to 75 cm) immature pods, which are used in similar ways as green beans. V. unguiculata (c.n Sitaw) varieties are usually distinguished by the color of its mature seeds (Sarada 2020).

Two tropisms discovered in root growth are positives geotropism (attach in the direction of gravity, sometimes considered a positive gravitropism) and barriers avoidance. In an unobstructed medium, most plants' roots do not grow straight downward. Circumnutation is characterized as an approximately clockwise direction all around the growth path, allowing the roots to develop downwards in waves and intertwine rather than in a linear way. Waves and knots on many plants straighten up with time, leaving no trace for circumnutation (Thomas 2017). As a result, the researcher was prompted to compare the twining action of the V. unguiculata (c.n Sitaw) vine to the direction in which the item touches.

Research Objectives

Generally, the study aims to determine the twining movement of the V. unguiculata (c.n Sitaw) vine using different diameter of the stick specifically 1.5cm, 3.0cm and 6.0cm.

Specifically, the study answers the statements hereafter enumerated.

1. Determine the age of the plants when their vines start to form.
2. Determine the significant differences between and among the treatment means in terms of the following parameters:

2.2. distance per twining; and
2.3. number of twining.
3. Determine the direction of twining of the plant.

Literature Review

Description of *Vigna unguiculata L*. (c.n Sitaw)

V. unguiculata (c.n Sitaw) seems to be a highly profitable leguminous vegetable crop. Vegetable cowpea is the common name given to it. Chinese long beans, string beans, snake bean, and snap pea are some of the other names for it. The common bean is not related to this plant. It's an annual vine that climbs quickly. It's a cowpea type grown for its impressively long (35 to 75 cm) immature pods, which have applications similar to green beans. The varied colors of the ripe seeds of *V. unguiculata* (c.n Sitaw) types are frequently distinguishable. Many pollinators, particularly yellow jackets and ants are attracted to the plant. It is a self-pollinating annual crop with less than 1% naturally crossings among plants in a row. The crop is primarily grown for its own green tender pods which are used as vegetables. South Asia, South China, Jakarta, the Philippine, Taiwan, and Thailand are among the countries where it is widely grown (Oblou, 2013).

V. unguiculata (c.n Sitaw) is a popular and important vegetable in the Philippines. It is also known as long beans, string beans, or pole *V. unguiculata* (c.n Sitaw). When compared to other legumes, *V. unguiculata* (c.n Sitaw) is termed "meat of the poor". It is high in protein and other nutrients. Because beans, like meat, are high in protein, they are known as poor meat (LaGuardia 2021).

Figure 1. *Vigna unguiculata L*. (c.n Sitaw)

V. unguiculata (c.n Sitaw) can withstand acidic soils, but prefers a pH range of 5.5–7.5. The plant prefers loose, friable soils that aren't overly nitrogen-rich. Overabundant leaf growth and decreased bean production can occur on nitrogen-rich soils. In preparation for sowing, choose a sunny location or loosen the soil to an eight- to ten-inch depth. The lengthy, trailing growth habit of the plant necessitates the use of a trellis for maximum yield. It takes about as much effort to train the vine as it does to grow tomatoes and peas. The plant can climb on its own, but it will require assistance and a sturdy trellis structure. Its vine should climb toward the top of their trellis, then don't make it too high. The vines must be supported by bamboo upright and rows plant growth promoting with poles and rope that would be at minimum seven feet tall. You can utilize a variety of trellising systems. Long beans will climb poles if they are not entirely vertical and thus are 3/4 inches to 2 1/2 inch in diameter, and they must be taught to poles early spring (John, 2012).

V. unguiculata (c.n Sitaw) seeds should be planted approximately an inch deep and 3 inches apart. The distance between rows should be roughly 24 inches. As seedlings sprout, thin them out to a 6-inch spacing. Sow twice at two-week intervals in warm zones, as well as a midsummer or autumn crop (Lannotti, 2001).

In the Philippines, *V. unguiculata* (c.n Sitaw) is among the most popular veggies. It is a genuine legume with a closer botanical relationship to cowpea. When such epidermis still is smooth and the seeds haven't matured or expanded, the fragile pods are delicious. Young leaves and stems could be cooked or boiled and eaten as greens. Green pods include 2 grams of protein, 8.2 grams of carbs, and a significant quantity for calcium and phosphate for 100g of fresh weight. Young leaves are rich in proteins and vitamin A when boiled. It can be grown all year, although the suitable for cultivation is during the wet season, from May to June, and during the dry season, between October to November (Berto 2019). *V. unguiculata* (c.n Sitaw) vines require stakes 25 days after they emerge to support them. 1 to 1.4cm diameter bamboo pole (Taculao 2020).

V. unguiculata (c.n Sitaw) have become an ancient vegetable that can still be seen growing wild throughout tropical Africa, in which they were most likely imported from Southeast Asia. Lengthy cowpea, spring bean, snake beans, and Chinese long bean are all names for the *V. unguiculata* (c.n Sitaw). They have unique beany flavor and are not as sweet as green beans. *V. unguiculata* (c.n Sitaw) are finest steaming, stir-fried, or braised short, although they also hold up nicely in stews. Blanch them before stir-frying to make them more juicy. For cooking, long beans should be sliced into 1-2 inch lengths. They

should be stir-fried or boiled instead of steamed, which makes it very soft (NESFP 2022).

V. unguiculata (c.n Sitaw) beans, like other legumes, are members of the legume family (Leguminosae or Fabaceae). Pole bean, bush beans, snap beans, and haricots (French beans) are not related to them. *V. unguiculata* (c.n Sitaw) peas are much more strongly linked to dark peas, and may even be variants of those peas. Long beans, on the other hand, can be substituted for these other beans in most recipes, though they are less sweet and tasty. Longer beans are never as stiff or crisp as green beans, even when harvested. When it is used in stew and other slow-cooked recipes, they are highly prized for their color and texture preservation (NESFP 2022).

Planting of *V. unguiculata* (c.n Sitaw)

V. unguiculata (c.n Sitaw) seeds can be stored for several years before being planted. The crop can be planted or seeded directly. When the seedlings have two genuine leaves, they can be transplanted. Transplanting provides for early crop establishment and an extension of the growing season, but it also necessitates more effort. Direct sowing is more popular in Florida. Seeds are sown 2 inches deep in elevated beds with plants three feet apart beds 6 feet apart. Because plants can grow to be 9 to 12 feet in height, trellis support is required. A 6-foot-tall trellis system supports the growing vines and makes harvesting easier (Lawrence 2012).

Harvesting the *V. unguiculata* (c.n Sitaw)

V. unguiculata (c.n Sitaw) can be harvested for two to three months from seeding, depending on region. When the seeds are not fully grown, this crop should be picked at an immature stage. Whenever the pod reaches 10 inches long, it is hand collected every day. After seeds have fully developed and matured, it can also be collected as dried beans. The plant's young leaves can be fed to cattle, and its huge, stunning violet blooms with draped pods can be utilized as a flowering plant in city gardens (Lawrence 2012).

Soil for growing *Vigna unguiculata L.* (c.n Sitaw)

When starting any form of plant, the topsoil is the most crucial environmental component to consider. The topsoil should have been loose, rich, and very well in order to grow long beans. The soil's typical pH should be between 6.0 and 7.5, ranging from acidic to mildly alkaline (Niena,2019). The vegetable can thrive in almost any climate and in any month, but it's best grown in areas with a temperature of 20 degrees Celsius to 35 degrees Celsius. It can also be grown in any type of soil as long as it has a pH level of 5.5 to 6.6. For the best results in growing *sitaw*, use loose soil that's rich in organic material (Taculao,2020)

When and how to support *Vigna unguiculata L.* (c.n Sitaw)

V. unguiculata (c.n Sitaw) vines require assistance from the start of their growth to produce runners. Once the plant reaches 0.5 feet in height, educate the runner stems to climb vertical on a stake by wrapping the *V. unguiculata* (c.n Sitaw) stems around it. At the start of the plant, you should keep a close eye on it. It might try to flee the stake. Then wrap them around the stake once more. You can put more stakes around the plant as it grows taller and stretches, depending on your needs (Texas 2019).

The ampalaya tendril would have an increased number of coils over the course of seven days when it was exposed to contact. This had 25 coils right from the start. The 2nd and 3rd days contained 26 coils, the fourth day 27 coils, the fifth day 28 coils, and the sixth day 29 coils. The tendon peeled off on the seventh day. Ampalaya's sensitivity to touch can be seen in the growing number of coils. A spiral coil is generated whenever the tendon contacts an item (Maria 2022).

Vines

Vine, a climbing plant with tendrils or twining that climbs or creep along surface, or even the stems of such a plant. (2017, Britannica). Circumnutation is the term for this circular growth. Vining plants' genetics enable them to grow quicker tip of the stems. The longer spacing between leaves on these lightweight tips allow the vine to coil around supports more easily. The cell outside the stems become taller than in touch with the support when such stem touches something. The stem curls and wraps around the support as a result. The stem tips tighten their grasp around the support even as weight of the plants pulls on them (Myers 2022).

Twining occurs when vines maintain themselves by wrapping around objects. Twiners are the name for such vines. When looking down at the vines from above, almost 90% of twining vine turn counterclockwise. Most of twine is wound in a clockwise direction.

Twining Beans and the Coriolis Effect

The Coriolis effect causes water to drain in one way in the northern latitudes and in a different way in the southern hemisphere. Some people believe that this happens with beans as well, but I haven't found any proof of this. Beans are twined in same way all across the world. Genetics, not geography, determines twining (Pavlis, 2021).

Thigmotropism

Tropism is a broad term that refers to every instance of an organism's growth or movement in reaction to its surroundings. Another type of tropism seen in vines is thigmotropism, which means vines response on touch (Rohit 2018). Tropism can take the form of positive or negative thigmotropism. A positive thigmotropism response is one that is directed toward the touch stimulus, while a negative thigmotropism response is one that is directed apart from the touch stimulus. Positive thigmotropism examples include the growth of vines on walls in response to contact with walls, as well as the curving of vines or twiners in response to contact with objects for support. The growth of roots beneath the soil surface is a type of negative thigmotropism. When a coiled - coil root comes into contact with anything, such as a rock, it travels away from it (Biology, 2020).

Methodology

Research Design

The researcher utilized an experimental design in the investigation. Experimental method, also known as experiment design, is a field of knowledge statistics that controls the planning, execution, analysis, and interpretation of controlled experiments for determining factors that influence the validity of a bunch of parameters. The experimental procedure is a data collecting and analysis technique that can be used in a range of settings. It takes time and dedication to appropriately design the study so that the necessary type of data is provided, but there's enough of it, to answer to concerns as quickly and efficiently as possible (Vedantu 2021)

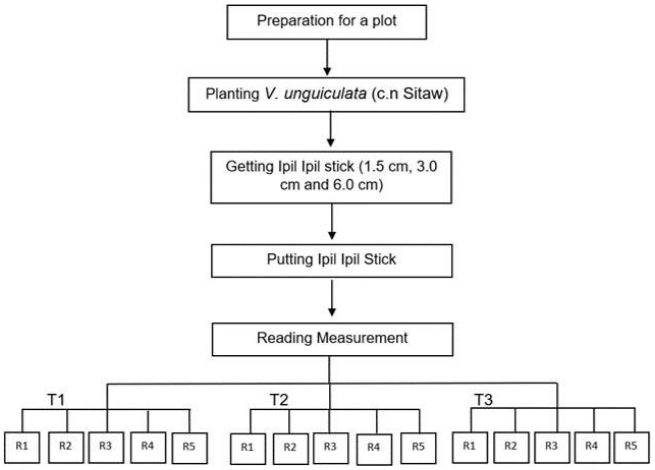

Figure 2. *Schematic Diagram for the Preparation of planting V. unguiculata (c.n Sitaw)*

Locale of Study

The study took place near the Madia Elementary School in Madia Datu Saudi, Maguindanao. On Mindanao's island, Madia can be found at 6.9683, 124.4674. The elevation is calculated to be 6.1 meters (20 feet) above sea level at these locations.

Equipment and materials used in the Study

1. rake
2. angled shovel
3. gardening gloves
4. bolo
5. seeds
6. ipil ipil stick (1.5 cm, 3.0 cm, and 6 cm)
7. meter stick
8. vernier caliper
9. pH meter
10. pitcher
11. pole sitao

Preparation for the Area

1. Choose a location where *V. unguiculata* (c.n Sitaw) can grow
2. Measure the area (13 m in height 7 m width)
3. Make a fence using fish net.

Testing the pH level of the soil

1. Establish the soil conditions in which *V. unguiculata* (c.n Sitaw) are grown.
2. Dig a sample 4 to 6 inches below the surface with a hand shovel.
3. Collect the sample 1 to 3 teaspoons of soil in a clean glass
4. Pour distilled water into the container.
5. Stir the earth around.

6. Place the pH meter on the window.
7. Write down the details.

Preparation of Plot

1. Obtain gardening tools such as a grab hoe and a rake.
2. Begin cultivating the soil with the grab hoe.
3. Fill the sacks with soil.
4. Each sack contains 30 kilograms of soil.

Planting of *V. unguiculata* (c.n Sitaw)

1. Plant three seeds in each one-inch-deep hole on the plot.
2. Make a two-inch space between the two points.
3. To allow the seed to establish roots, put one seed for each hole.
4. Near the seed hole, put a 5 inch peg.
5. Pour 1 L of water into all replicate every 6 a.m. and 4 p.m. to aid in their germination.
6. When the plants have started to grow, pick one healthiest of the three and toss the others.

Support for climbing

1. Obtain Ipil ipil sticks with diameters of 1.5 cm, 3.0 cm, and 6.0 cm (5 pieces of 1.5 cm pole stick, 5 pieces of 3.0 cm pole stick and 5 pieces of 6.0 cm pole stick) with a height of 2 m each.
2. Place the pole beside the string beans to provide climbing assistance (2 inch from its stem)

Reading its Measurement.

1. When the vines start to grow, count how many there are.
2. After 24 hours, keep track of the twining direction and number.
3. Every vine's twining orientation should be noted.

Results and Discussion

The Age of the Vine Tip Start to Grow

Table 1 below shows the number of days the seeds start to sprout for 3 planting plots containing different diameter (1.5 cm, 3.0 cm, and 6.0 cm) of pole used as a medium of twining of the vines.

Table 1. *Number of days the vines start to grow for the 3-planting plots containing different diameter (1.5 cm, 3.0 cm, and 6.0 cm) of two-meter-long poles.*

Treatment (Pole Diameter, cm)	Replicates	Number of Days the Vines Start to Grow			
		Day 23	Day 24	Day 25	Day 26
T_1- 1.5	1	X	X	X	/
	2	X	X	X	/
	3	X	X	X	X
	4	X	/	/	X
	5	X	X	X	/
T_2 - 3.0	1	/	X	X	X
	2	X	/	X	X
	3	X	X	/	X
	4	/	X	X	X
	5	/	X	X	X
T_3 - 6.0	1	X	X	X	/
	2	X	X	X	/
	3	X	X	X	/
	4	/	X	X	X
	5	X	X	/	X

Legend x: No vine tip /: Begin to produce vine tip

For each replicate, *V. unguiculata* (c.n Sitaw) vine tips appear on day 23rd to 26th day. On day 26th, treatments with 1.5cm diameter vine tips was seen. The vines tips are generally evident on day 23 after treatments with 3.0cm pole diameter. Furthermore, around day 26, the majority of vine tips reveal for treatments with the 6.0 cm pole diameter.

Measurement of Plant Growth in Terms of Distance per Twining

The mean distance per twining of the plant vines for 3 treatments with different diameter of pole (T_1 =1.5 cm, T_2 =3.0 cm, and T_3 = 6.0 cm).are shown in Table 2 below.

Table 2. *Distance per twining for different pole diameter (1.5 cm, 3.0 cm, and 6.0 cm, n= 15).*

Treatment (Pole diameter cm)	Distance per Twining (cm)					Mean (cm)
	I	II	III	IV	V	
T_1 (1.5 cm)	15.7	15.0	14.7	15.5	16.0	15.4^B
T_2 (3.0 cm)	14.7	15.5	17.0	16.5	16.3	16.0^B
T_3 (6.0 cm)	20.0	22.4	20.8	15.2	22.6	20.2^A
Grand Mean						16.9

Note: Means not sharing letters in common differ significantly from Duncan's Multiple Range Test.

The mean distance on the pole for every twine of vines for T1 with 1.5 cm pole diameter is 15.4B and T2 with a 3.0 cm pole diameter has a mean of 16.0B while the T3 with a pole diameter of 6.0 cm is 20.2A with the grand mean of 16.9 cm. The data shows that there is no significant difference between T1 - T2 and there is significant difference between and among the T1 - T3, and T2 - T3.

The data on the distance every twining appears to be stretched, but it confirms that the plants are gelatinous fibers (Leech, 2017). Coiling or twining in vine were induced by the existence of gelatinous fibers, according to (Bowling & Vaughn, 2019).

Furthermore, according to Scher et al., 2001, a twining stem, such as *Vigna unguiculata L.*, grows around a cylindrical support, forming a helix tube of tissue with consistent curvature and torsion. The vine's natural tendency to produce a twine with a smaller radius and greater torsion changes with the diameter of the supports pole. In addition, the shape of the helix created by the vine on the pole impacts the vine's ability to sustain a frictional connection with its support, according to the study on Temporal and spatial pattern of twining forces and shoot growth in branches of *Ipomoea purpurea*. As a result, the twining force was smaller on the thinner poles (6.35 mm) than on the thicker ones.

Measurement of Plant Growth in Terms of the Number of twining per Vines

The number of twining of vines for 3 treatments with different diameter of pole (T_1 =1.5 cm, T_2 =3.0 cm, and T_3 = 6.0 cm).

Table 3. *The Number of twining for different pole diameter (1.5 cm, 3.0 cm, and 6.0 cm, n= 15) for 18 days.*

Treatment (Pole diameter, cm)	*Number of Twining per Vine*					*Mean*
	I	*II*	*III*	*IV*	*V*	
T_1 (1.5 cm)	14	14	16	17	19	16^A
T_2 (3.0 cm)	13	15	15	13	13	13.8^A
T_3 (6.0 cm)	6	6	7	8	7	6.8^B
Grand Mean						36.6

Note: Means not sharing letters in common differ significantly from Duncan's Multiple Range Test.

The mean number of twines for T1 with a 1.5 cm pole diameter is 16A. For T2 with a 3.0 cm pole diameter has a mean of 13.8A whereas the T3 with a 6.0 cm pole diameter is 6.8B with the total grand mean of 36.6 for all the treatments. The data shows that there is no significant difference between and among the treatment with T1 - T2 with 1.5 cm and 3.0 cm pole diameter and there is significant difference between T1 – T3 and T2 – T3 with 1.5 cm - 6.0 cm and 3.0 cm and 6.0 cm pole diameter.

The diameter of the supporting 2 meters long pole has an effect on the quantity of twines. The capacity of twining vine to grasp the pole is influenced by the support pole, as evidenced by the findings of Scher et al., 2001, who found that magnitude of twining force was lower on thinner pole (6.35 mm) than those on larger ones (19.05 mm).

The Twining Direction of Vine

The twining direction is observed in every vine for 3 treatments with different diameters of poles (1.5 cm, 3.0 cm, and 6.0 cm). The observation is replicated 5 times as shown in table 4 below.

Table 4. *The Direction of Twining of Vines at Different Treatment with 1.5 cm, 3.0 cm, and 6.0 cm (n=15)*

Treatment	*Direction of Twining for every vine*				
	I	*II*	*III*	*IV*	*V*
T_1 (1.5 cm)	Counterclockwise	Counterclockwise	Counterclockwise	Counterclockwise	Counterclockwise
T_2 (3.0 cm)	Counterclockwise	Counterclockwise	Counterclockwise	Counterclockwise	Counterclockwise
T_3 (6.0 cm)	Counterclockwise	Counterclockwise	Counterclockwise	Counterclockwise	Counterclockwise

The twining direction of vines in every treatment with 1.5 cm, 3.0 cm, and 6.0 cm pole diameter is generally counterclockwise in direction. The most of beans twine counterclockwise and twining is governed by genetics rather than location, according to the findings (Pavlis, 2021).

The majority of vines twine in a clockwise direction, however only 10% do so. Some people combine the two approaches whether a vine grows north or equatorial has no bearing on how it twines. The direction of twining is determined by genetics, with certain species going one way and others going another (Conrad, 2010).

Conclusion

The age of the plants when its vines tips begin to appear is mostly seen between 23 to 26th. The distance per twining is long for all the treatments. There is no significant difference between and among the treatment with pole diameter of 1.5cm and 3.0cm, and there is significant difference between and among the treatment pole diameter of 1.5cm and 6.0 cm and 16.0 and 20.2 in terms of distance per twining. There is no significant difference between and among the treatment with pole diameter of 1.5cm and 3.0cm, however, there is significant difference between treatment pole diameter of 1.5 cm and 6.0, 3.0 and 6.0 cm in terms of number of twines per vine. Lastly, the direction of twining is counter clock wise for all the plant plots with pole diameter of 1.5 cm, 3.0 cm, and 6.0 cm.

It is recommended that educators should be guided of the growth, yield and health benefits of the *V. unguiculata* (c.n Sitaw) as one of the basic vegetables in the community. The effective treatment as a result of this study will be applied to form part of community farmers productivity.

It is also recommended for the future researchers to use different variety of seeds and diameter of the pole in comparing all treatments. Study also the number of their leaves and its height.

References

Angeles M. 2022 “Experiment10 - Exercise #10 Plant Movement and Maria Agatha Angeles, Karl Christian Buerano, Kenneth Guevarra &Melizza Soriano Group # 2,: Course Hero.”

Bailey, R. 2018 “How Plants Respond to Light, Touch, and Other Stimuli.” *ThoughtCo*, ThoughtCo

Berto, J. 2019 “Sitaw Health Benefits.” *The Philippines Today*”

Biology Online 2020 “Thigmotropism.” *Biology Articles, Tutorials & Dictionary Online*, 26 Jan. 2020.

Britannica, 2017 The Editors of Encyclopaedia. "vine". *Encyclopedia Britannica*, 17 Mar. 2017, Accessed 22 May 2022

Bowling, K. V. 2019 “Gelatinous Fibers Are Widespread in Coiling Tendrils and Twining Vines.” *American Journal of Botany*, U.S. National Library of Medicine,

Conrad, J. 2010 “counter clock wise and clockwise tendrils” Newsletter issued from Hacienda Chichen Resort beside ChichénItzá ruins, central Yucatán

Durner, E. F. “Principles of Horticultural Physiology.” *Google Books*, Google,

Garretson, L. 2020 “Vines Serve Many Purposes.” *The Victoria Advocate”*

Goldstein G. M, and Monasterio M. 1984 The role of capacitance in the water balance of Andean giant rosette species. *Plant, Cell and Environment*7179–186.

Lannotti,M. 2021 “Learn How to Grow Yardlong Beans.” *The Spruce*, The Spruce.

Lawrence *J. H.* 2012 Pacific Islands West Area Office, Pacific Islands Area, Mongmong, GuamEdited: 070212 jsp; 070322 jsp

Lawrence, J. H. and Moore L.. 2012. *Plant Guide: Yardlong Bean*. USDA Natural Resources Conservation Service. Accessed October 1, 2015.

LaGuardia, B. 2021 “Sitaw Farming: How to Plant and Grow String Beans for Profit.” *Agriculture Guide*, 19 Oct. 2021

Leech, J. 2017 “Good Fiber, Bad Fiber - How the Different Types Affect You.” *Healthline*, Healthline Media, 4 June 2017.

Marie. 2021 “Learn How to Grow Yard long Beans.” *The Spruce*, The Spruce

Myers, M. 2022 “Why Vines Twine.” *Melinda Myers*,

Neina, D. 2019 “The Role of Soil Ph in Plant Nutrition and Soil Remediation.” *Applied and Environmental Soil Science*, Hindawi,

NESFP, 2022 “New Entry Sustainable Farming Project.”*Long Beans | New Entry Sustainable Farming Project* 2022

Obatolu, V. A. 2003. "Growth pattern of infants fed with a mixture of extruded malted maize and cowpea". *Nutrition*. 19 (2): 174–178.

Pavlis, R. 2021 “Twining Direction in Beans - Are Scarlet Runner Beans Different” *Garden Myths*, 18 Oct. 2021.

Rohit, K. 2018 “Vines.” *Science in the News*, 11 Jan. 2018,

Sarada C. and Hari N. 2020 “Evaluation of Yard Long Bean Vigna unguiculata subsp. sesquipedalis (l.) Verdcourt) Genotypes in Vertisols of Andhra Pradesh” ISSN: 2319-7706

Scorza, L. T. and Marcelo C. D. 2011 “Plants on the Move: Towards Common Mechanisms Governing Mechanically-Induced Plant Movements.” Plant Signaling & Behavior, Landes Bioscience”

Smith A. P. 1980 The paradox of plant height in an Andean giant rosette species. *Journal of Ecology*68,63–73.

Scher, J. L., et al 2001. “Temporal and Spatial Patterns of Twining Force and Lignification in Stems of Ipomoea Purpurea.” *Planta*, vol. 213, no. 2, 2001, pp. 192–98. *JSTOR*

Taculao, P. S. 2020 “A Quick Guide to Producing Sitaw.” *Agriculture Monthly*, Agriculture Monthly.

Texas H. L. 2019 “How to Grow Green Beans in a Garden - Growing Green Beans in Backyard.” *Texas A&M AgriLife Extension Service*

Thomas B. 2017 ” “Gravitropism. *Gravitropism - an Overview | ScienceDirect Topics*, Plant Physiology and development.

Affiliations and Corresponding Information

Rowena Zainudin, LPT, MSciEd
Gani L. Abpi College Inc. - Philippines

Haron Mohamad, LPT, MAELT
MBHTE-BARMM Talitay National High School - Maguindanao-1 Division, Philippines

Datu Raffy Ralph Sinsuat, MSc.IT
BARMM -Bangsamoro Information and Communications Technology Office, Philippines