A Monograph on *Gloriosa superba* L.: an Agroecological and Biological Study

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Chapter 1: Introduction

Gloriosa superba L., commonly known as the flame lily, is a climbing plant of significant biological, ecological, and economic importance, with a very striking appearance. Native to tropical regions of Africa and Asia, this species stands out not only for its distinctive shape and vibrant flowers but also for its role as a major source of the alkaloid colchicine, a compound widely used in modern medicine. Its dual identity as both an ornamental plant and an important resource for medicine explains its growing scientific and agricultural interest.

The selection of *Gloriosa superba L.* for this monograph comes from two specific areas, its shape and colors, and the presence of such a unique compound. It plays a crucial role in global pharmaceutical markets, particularly in regions where it is cultivated as a high-value cash crop, highlighting the importance and demand of colchicine. Its toxicity is also notable and a factor for its selection. This alkaloid, while a product with a high demand, also has notable risks, possessing a deadly toxicity that gives it another layer of interest. The shape of the flower, along with its climbing behavior, makes it a visually stunning plant. Its uncommon features and shapes, along with the colors, were an important factor when selecting it.

This monograph aims to provide a comprehensive understanding of *Gloriosa superba* by examining it through multiple scientific and socioeconomical perspectives. Chapter 2 explores the agroecological context of the species, including its taxonomy, origin, distribution, habitat, and environmental requirements. Chapter 3 follows with a focus on its biological characteristics, detailing its chromosome structure, life cycle, reproductive biology, and flowering behavior. Chapter 4 addresses propagation and management practices, covering both natural and artificial regeneration methods, cultivation techniques, and challenges in production. Finally, Chapter 5 examines the economic dimension of the species, including its market importance, global production, trade structure, and diverse uses, particularly in medicine.

By integrating these perspectives, this monograph highlights the importance of *Gloriosa superba L.* not only as a biological organism but also as a resource of economic and scientific value. It dives deep into the diverse fields this plant crosses through and shows how a single plant can affect much more than one might think it will. Understanding this species in a holistic way allows for better conservation, sustainable cultivation, and informed utilization in the future.

Chapter 2: Agroecology

2.1 Taxonomy

The genus *Gloriosa* L. was first established by Linnaeus (1753) and published in *Species plantarum,* with a single species named *Gloriosa superba* L. The botanical authority for this genus and species is Carl von Linnaeus, referenced with the L., this is the first person that discovered and coined the name. This species is commonly referred to as flame lily, or tiger's claw. *Gloriosa superba* L. is classified into specific taxa according to its characteristics, the broadest rank is kingdom, it belongs to the Plantae kingdom. Plantae include all land plants, which are "multicellular and eukaryotic" (Dickinson et al., 2025a). Apart from this, they also have pigments, like chlorophyll, that enables them to convert the sunlight's energy to chemical energy, and then store the excess into starch, meaning they are autotrophs (Dickinson et al., 2025a). Their cells are connected by plasmodesmata, strands of cytoplasm, and their growth at localized meristems enables continual increase in size (Dickinson et al., 2025a).

The next division is the Tracheobionta subkingdom. These are the vascular plants, they "possess specialized supporting and water-conducting tissue, called xylem, and food-conducting tissue, called phloem" (Dickinson et al., 2025b). Xylem is reinforced with lignin to conduct water, while phloem conducts sugars. The presence of vascular tissues provides true stems, roots, and leaves, providing stability and enabling larger growth on land (Dickinson et al., 2025b). Additionally, plants in the Tracheobionta subkingdom have adaptations like a waxy layer, called a cuticle, to decrease water loss, and stomata to permit gas exchange (Dickinson et al., 2025b).

Following the subkingdom, *Gloriosa superba* L. is part of the Spermatophyta superdivision, more commonly known as the seed plants. As the name says, these plants reproduce via seeds and pollen. The taxonomic division Spermatophyta is no longer used but refers to the "angiosperms (flowering plants) and gymnosperms (conifers, cycads, and allies)" (Petruzzello, 2022). The next division is the more used one, the Magnoliophyta or Angiosperm division, or the flowering plants. These have an egg (ovule) that is fertilized into a seed, encased in an ovary, inside the flower (Cronquist et al., 2025). The Liliopsida class are plants called monocotyledons, that, when in the embryo, only has one cotyledon, a seed leaf (Takhtajan, 2009, p. 589). The next subclass is Liliidae, the largest monocot subclass, characterized by a tough succulent stem to survive stressful conditions (Institute of Biological, Environmental & Rural Sciences, 2025). Next, the Liliales order is known as the 'lily order,' they are typically perennial herbs or climbers (Kress & Traub, 2017). Additionally, "the leaves of Liliales are either straplike with parallel venation or ovate with palmate veins and reticulate minor venation" (Kress & Traub, 2017).

Inside the Liliales order, there is the Colchicaceae family, which is characterized by the presence of the colchicine alkaloid. This makes the plants in this family very poisonous to humans and animals (Watson & Dallwitz, 1994). The genus *Gloriosa,* inside the Colchicaceae family, refers to "tuberous-rooted plants… native to tropical Africa and Asia" (The Editors of Encyclopaedia Britannica, 2008). They are known as climbing lilies or glory-lilies and have vinelike stems with narrow leaves (The Editors of Encyclopaedia Britannica, 2008). Finally, the *Gloriosa superba* L. species, commonly known as flame lily, is characterized by climbing stems growing from an elongated, forked corm, with varying flower colors like “cream, yellow, orange, red, maroon or purple-brown, many forms with yellow margins on the tepals” (Hyde et al., 2025)

Table 1

Taxonomic classification of Gloriosa superba L.

TAXONOMIC RANK	TAXON NAME (AUTHORITY)	NOTES
Kingdom	*Plantae*	Plants
Subkingdom	*Tracheobionta*	Vascular plants
Superdivision	*Spermatophyta*	Seed plants
Division	*Magnoliophyta*	Flowering plants
Class	*Liliopsida*	Monocotyledons
Subclass	*Liliidae*	
Order	*Liliales*	
Family	*Colchicaceae*	
Genus	*Gloriosa L.*	
Species	*Gloriosa superba L.*	Flame lily

Note. Adapted from *Classification for Kingdom Plantae Down to Species Gloriosa superba L.*, by Natural Resources Conservation Service, 2025 (https://plants.sc.egov.usda.gov/classification/28615). Depicts taxonomic hierarchy of *Gloriosa superba L.*

2.2 Fossil Record

After meticulous research, there is no fossil record for neither the species nor genus. When searching for the *Colchicaceae* family’s fossil record, Chacon Pinilla (2013) states that there is an absence of a fossil record. This may be the case because of the soft tissues that make up the species decompose too quickly and almost never fossilize. That would happen with plants that consist of more woody or hard structures, like tree trunks or pollen grains. Additionally, the plant’s habitat is very poor for fossil preservation, which will be delved into later.

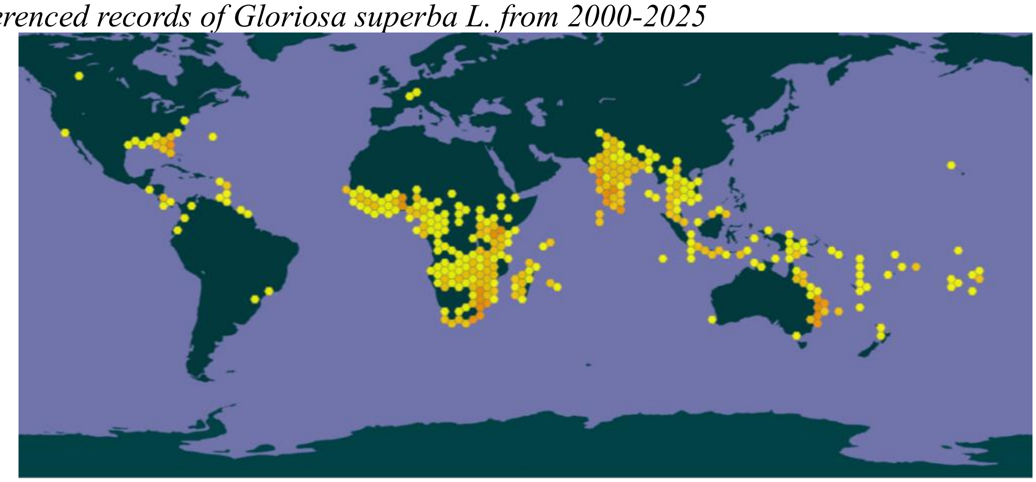
2.3 Origin and Current Distribution

Gloriosa superba L. has its origins in tropical regions of Africa and Asia. Its native range spans a lot of sub-Saharan Africa and South and Southeast Asia. For example, Kew’s Plants of the World Online notes that “the native range of this species is Tropical & S. Africa, W. Indian Ocean, Indian Subcontinent to Lesser Sunda Islands" (Kew Science, 2025). *Gloriosa superba* L. occurs "in the Eastern Cape, KwaZulu-Natal, Mpumalanga, Limpopo and Northwest provinces in South Africa, and in Swaziland, Botswana, Namibia, Angola and Zimbabwe and into tropical Africa, India and southeastern Asia" (Notten, 2015). To sum up, *G. superba* L. occurs naturally across tropical Africa and eastward through Southeast Asia. Beyond its indigenous range, *Gloriosa superba* L. is now widely naturalized in Europe and Australia, according to Kew Science (2025). Also, they state that it is "listed as a weed in Australia and in some parts of the USA" (Kew Science, 2025). Kew also notes that it is extensively cultivated in the Americas, specifically Colombia.

The current distribution of *G. superba* L. is largely based on the origin and its native range, with some areas like Florida or South America where there is some presence. As shown in Figure 1, most of the records of this species are in the tropical regions mentioned before, with a clear abundance in sub-Saharan Africa and South and Southeast Asia. These records are recent, from 2000 to present time, showing an ample population of *G. superba* L. currently. Comparing with the origins explained before, Figure 2 displays a map with the records from 1822 to 1882, exhibiting a clear presence of *G. superba* L. in both sub-Saharan Africa and Southeast Asia, that, with time, will evolve to look like Figure 1.

Figure 1

Georeferenced records of Gloriosa superba L. from 2000-2025



Note. Retrieved from Bánki, O., Roskov, Y., Döring, M., Ower, G., Hernández Robles, D. R., Plata Corredor, C. A., Stjernegaard Jeppesen, T., Örn, A., Pape, T., Hobern, D., Garnett, S., Little, H., DeWalt, R. E., Miller, J., Orrell, T., Aalbu, R., Abbott, J., Abreu, C., Acero P, A., … World Flora Online. (2025). *Catalogue of Life* (Versions 2025-10-10 XR) [Dataset]. Catalogue of Life Foundation. https://doi.org/10.48580/DGTPL. Depicts current records and occurrences of *Gloriosa superba L.*

Figure 2

Georeferenced records of Gloriosa superba L. from 1822-1882

Note. Retrieved from Bánki, O., Roskov, Y., Döring, M., Ower, G., Hernández Robles, D. R., Plata Corredor, C. A., Stjernegaard Jeppesen, T., Örn, A., Pape, T., Hobern, D., Garnett, S., Little, H., DeWalt, R. E., Miller, J., Orrell, T., Aalbu, R., Abbott, J., Abreu, C., Acero P, A., … World Flora Online. (2025). *Catalogue of Life* (Versions 2025-10-10 XR) [Dataset]. Catalogue of Life Foundation. https://doi.org/10.48580/DGTPL. Depicts former records and occurrences of *Gloriosa superba L.*

2.4 Ecoregion

Gloriosa superba L. shows a wide amplitude ecological amplitude across tropical and subtropical regions, surviving in diverse ecoregions characterized by seasonal moisture availability. Mahr (2025) notes that *G. superba* is native to "tropical and southern Africa and temperate and tropical Asia (from China to India)". It grows in a wide variety of warm climate habitats, from "brushwood, hedges and open forest" (Plants For A Future, 2024), to forests, thickets, grasslands and even sand dunes (Mahr, 2025). It typically occupies forest and savanna, being the "most common in forest-savanna boundaries." (Schmelzer & Gurib-Fakim, 2008, p.312). It is very abundant, as said before, in "thickets, hedges, open forest, grassland and bushland" (Schmelzer & Gurib-Fakim, 2008, p.312). Although tolerant of nutrient-poor soil (Plants For A Future, 2024), it does require some moisture, normally in the form of seasonal rainfall (Tamil Nadu Agricultural University, 2025). The species can occur from sea-level up to 2500 m altitude (Schmelzer & Gurib-Fakim, 2008, p.312). This wide range of altitudes shows that it can span a broad topographic sequence. The plant's ecoregions include tropical forests and mixed savanna and woodlands, environments with warm temperatures and seasonal moisture.

2.5 Climate

Gloriosa superba L. prefers warm and humid climates with a pronounced rainy season. Mahr (2025) refers to it as growing in zones 8-12 in the USDA Plant Hardiness Zone Map, which means frost-free or nearly frost-free climates. According to Schmelzer and Gurib-Fakim (2008), *G. superba* avoids permanently humid climates, preferring rainy seasons (p. 312). Its high moisture demand requires an annual rainfall of 350 to 400 cm but cannot tolerate prolonged moisture stress (Tamil Nadu Agricultural University, 2025), this means the plant does best in monsoon-like climates, hot, humid summers and moderate nights. The temperature for optimal growth is declared by Mahr (2025) as around 60°F at night and 70°F in the day, that, converted, is 16°C and 21°C. These climatic conditions coincide with humid tropics and subtropical highlands, while being the opposite from true desert or cold temperate zones. In sum, the climates that *G. superba* prefers are warm moist ones with a rainy season, with its toposequence distribution, avoiding extreme upland cold or arid lowlands, reflecting its need for a warm, humid climate with seasonal rains.

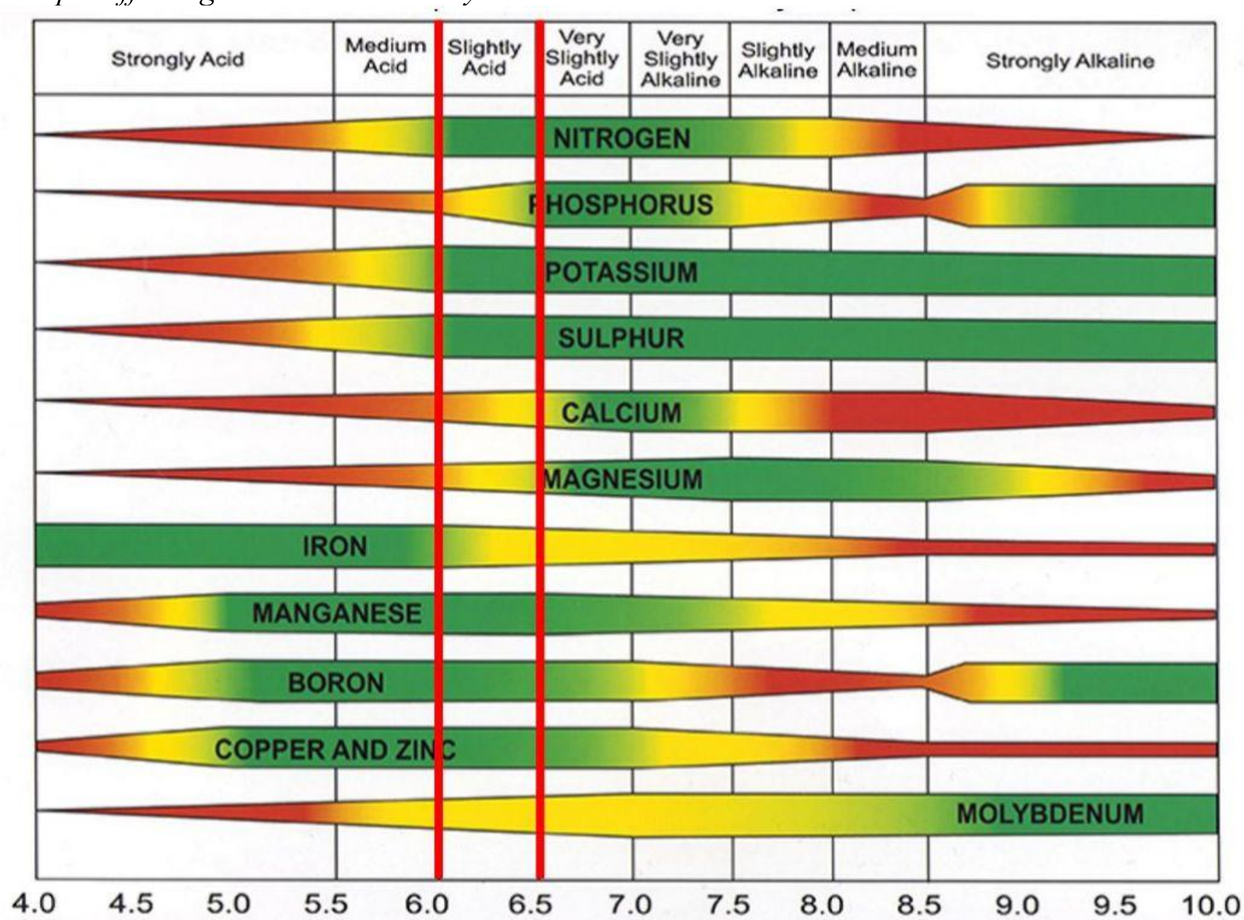
2.6 Geology and soil requirements

Plants need 17 essential nutrient elements to grow, including carbon, hydrogen and oxygen obtained from water and air, while the other 14 are obtained through the soil. The function and categorization of these nutrients will be expanded upon in 2.7. In research done by Haussecker et al. (2023), fertilization rich in nitrogen, phosphorus, and iron is recommended in the vegetative stage, balanced nutrition during the visible shoot stage, and enrichment with calcium, potassium, magnesium, manganese, zinc, and copper during flowering. Interestingly, the presence of arbuscular mycorrhizal (AM) fungi in the soil, along with a phosphorus-rich fertilizer, creates a mutually beneficial relationship, increasing the tuber biomass of *G. superba*, and consequently, enhancing its growth (Pandey et al., 2014). Next, the soil texture is very important. This refers to the proportion of sand, silt, and clay particles, with each texture showing different responses to water (Clark, 2025). While adding organic matter does not change the soil's texture (percentage of sand, silt, and clay), it affects soil structure by increasing pore space and improving water drainage, which is carried out to arrive at a soil with a ratio of 50% pore space and 50% solids (Moore & Bradley, 2022). Chen et al. (2025) states that "variations in soil particle size have a profound impact on natural processes such as water evaporation, infiltration, drainage, gas diffusion, heat conduction, and nutrient transport". This impact alters the soil's physical properties that are vital for both root development and nutrient uptake. All these changes stemming from a difference in soil texture highlight the caution needed when choosing one.

G. superba's texture requirements are very flexible, the suitable types of soil are "light (sandy), medium (loamy) and heavy (clay)… and prefers well-drained soil" (Plants For A Future, 2024). As stated by Pandey et al. (2014), cultivation has been successful in sandy loam texture, indicating a possible preference of moderately textured soils that balance water retention with drainage. Its adaptability is noteworthy since it has also been found to grow in free-draining soils (Fernando & Widyaratna, 1997). Additionally, the soil pH is important to have in mind, since it affects nutrient availability. According to McCauley et al., "a soil's ability to hold and supply nutrients is related to its cation and anion exchange capacities," (2017). So, the soil pH affects the nutrient availability because the hydrogen ions take up space on the negative charges along the soil surface, displacing the actual nutrients. For *G. superba,* the suitable pH is a neutral pH, around 6 to 7 (Plants For A Future, 2024). This ideal pH range is due to it having the greatest availability of most nutrients (Sharma et al., 2022). In Figure 3, the ideal pH range is highlighted as 6.0 to 6.5, being the range where there is the best availability of most nutrients.

Figure 3

Soil pH affecting nutrient availability in the soil.



Note. From Sharma, L. K., McCray, J. M., & Morgan, K. (2022). Plant Essential Nutrients and Their Role: SS-AGR-463/AG462, 5/2022. *EDIS*, *2022*(3). https://doi.org/10.32473/edis-ag462-2022. Exhibits availability of different nutrients depending on pH.

2.7 Water Management

Gloriosa superba L. evolved in rainy climates, this means it needs consistent moisture to actively grow. According to the Tamil Nadu Agricultural University (TNAU, 2025), an annual rainfall of 350-400mm is ideal, they also explain moisture stress is very harmful, and frequent irrigation up to flowering is the best (p. 2). Additionally, TNAU notes that "rains during December damage the crop and affects yield" (TNAU, 2025, p. 2). This explains that *G. superba* L. grows most efficiently with ample water in spring and summer, but the amount of water needs to be lowered in winter. When referring to a more structured management, TNAU (2025) states an irrigation interval of 4 to 7 days early on and a 15-day interval later (p. 4). To have a guideline, a plant needs around 5 liters of water a day. Also, TNAU explains that "no irrigation is required after flowering" (TNAU, 2025, p. 4). They also state that two methods of irrigation are very common. Flood irrigation is very popular in cultivated areas, and drip irrigation is receiving popularity. A key concept to have in mind when determining the amount of water to irrigate is evapotranspiration (ET). According to Richard Allen, ET is "the combination of two separate processes whereby water is lost on the one hand from the soil surface by evaporation and on the other hand from the crop by transpiration" (Allen, 2000). What this means in terms of irrigation is that, when the temperature increases, *G. superba* L. will lose water quickly through its stomata and the soil surface around it. Thus, when in dry and hot climate, the plant must be watered more frequently to replace the increased water lost by ET. On the other hand, a humid and shaded environment will lower ET, leading to more water retention and less extra water needed. Evapotranspiration needs to be thoroughly understood so water management can be correctly modified depending on the temperature and amount of sun it receives.

The nutrients absolutely needed by *G. superba* L. are the same ones needed by every plant, separated into primary, secondary, and micronutrients. McFarland & Provin (2025) says the primary nutrients are carbon, hydrogen, nitrogen, oxygen, phosphorus, and potassium. These are needed in the largest amounts. Next, the secondary nutrients needed, in more moderate amounts, are calcium, magnesium, and sulfur. Finally, micronutrients are needed in very small amounts, these are boron, chlorine, copper, iron, manganese, molybdenum, and zinc (McFarland & Provin, 2025). To take in these essential nutrients, McFarland & Provin (2025) note that almost all are taken in from the roots, except for carbon, taken in through stomata. In Table 2, all the nutrients are shown with much more detail explaining their function and the ionic form it is taken up as.

Table 2

Information of nutrients with form, mode of uptake, and major function

Nutrient Family	Nutrient	Percentage of plant	Form taken up by plant (ion)	Mode of uptake	Major functions in plants
Primary	Carbon	45	Carbon dioxide (CO_2), bicarbonate (HCO_3)	Open somates	Plant structures
Primary	Oxygen	45	Water (H_2O)	Mass flow	Respiration, energy production, plant structures
Primary	Hydrogen	6.0	Water (H_2O)	Mass flow	pH regulation, water retention, synthesis of carbohydrates
Primary	Nitrogen	1.75	Nitrate (NO_3), ammonium (NH_4^+)	Mass flow	Protein/amino acids, chlorophyll, cell formation
Primary	Phosphorous	0.25	Dihydrogen phosphate (H_2PO_4-, HPO_4^{2-}), phosphate (PO_4^{3+})	Root interception	Cell formation, protein syntheses, fat and carbohydrate metabolism
Primary	Potassium	1.5	Potassium ion (K^+)	Mass flow	Water regulation, enzyme activity
Secondary	Calcium	0.50	Calcium ion (Ca^{2+})	Mass flow	Root permeability, enzyme activity
Secondary	Magnesium	0.20	Magnesium ion (Mg^{2+})	Mass flow	Chlorophyll, fat formation and metabolism
Secondary	Sulfur	0.03	Sulfate (SO_4^{2-})	Mass flow	Protein, amino acid, vitamin and oil formation
Micro	Chlorine	0.01	Choloride (Cl-)	Root interception	Chlorophyll formation, enzyme activity, cellular development
Micro	Iron	0.01	Iron ion (Fe^{2+}, Fe^{3+})	Root interception	Enzyme development and activity
Micro	Zinc	0.002	Zinc ion (Zn^{2+})	Root interception	Enzyme activity
Micro	Manganese	0.005	Manganese ion (Mn^{2+})	Root interception	Enzyme activity and pigmentation
Micro	Boron	0.0001	Boric acid (H_3BO_3), borate (BO_3^{3-}), tetraborate (B4O7)	Root interception	Enzyme activity
Micro	Copper	0.0001	Copper ion (Cu^{2+})	Mass flow	Enzyme activity
Micro	Molybdenum	0.00001	Molybdenum ions ($HMoO^{4-}$, MoO_4^{2+})	Mass flow	Enzyme activity and nitrogen fixation in legumes

Note. From McFarland, M. L., & Provin, T. L. (2025). Essential Nutrients for Plants. *Texas A&M AgriLife Extension Service*. https://agrilifeextension.tamu.edu/library/gardening/essential-nutrients-for-plants/. Portrays nutrients with their percentage in plants, the form used, how it's taken up, and its function.

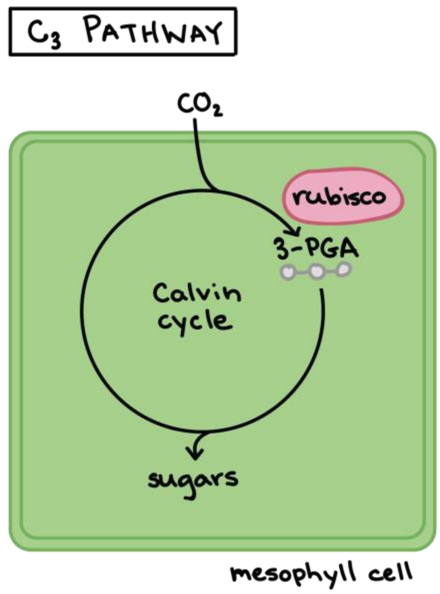
2.8 Light and Temperature regimes

Gloriosa superba L. grows in “sunny, semi-shaded or lightly shaded” habitats (Notten, 2015), so the light intensity is vital for its correct and optimal growth. Low or very high light intensity, as stated by Zhang et al. (2022), influences photosynthesis, causing photoinhibition. So, under low or too much light, photosynthesis, and consequently growth, is severely limited. Geiger (2017) notes that plants adapted to the sun have a max photosynthetic capacity much higher than that of a shade plant, while plants adapted to the shade can survive at lower rates. *G. superba*’s ability to grow in both conditions suggest it balances these strategies, optimizing light captured in various intensities. Overall, sufficient light at the right intensity is needed so *G. superba* L. can carry out its photosynthesis and growth, but it is flexible on the intensity it requires.

Like most tropical vines, *G. superba* L. uses the C3 (Calvin cycle) photosynthetic pathway, common in *Colchicaceae*. The C3 pathway uses the enzyme RubisCO to catalyze the carbon fixation reaction. According to Monash University, the reaction happens “between RuBP (a 5-carbon sugar), and CO_2” (Monash University, 2025). Monash University (2025) notes that this reaction creates a 6-carbon compound that breaks down into two 3-carbon molecules called PGA, which then, through a series of steps, convert to G3P, that then combine to produce glucose, the final needed product. Figure 4 demonstrates the C3 pathway visually, explaining the starting reactant, with the RuBisCO catalyzer that produces PGA, and then finally producing the sugars needed for the plant to grow.

Figure 4

Pathway of C3 photosynthesis



Note. From Khan Academy. (2025). *C3, C4, and CAM plants (article)*. Khan Academy. https://www.khanacademy.org/science/biology/photosynthesis-in-plants/photorespiration--c3-c4-cam-plants/a/c3-c4-and-cam-plants-agriculture. Exhibits Calvin cycle, from reactant, CO_2, until it produces sugars.

Temperature has a strong effect on the growth *G. superba* L. presents. This is the case because photosynthesis has a thermal optimum, the efficiency rises with temperature, then declines because of heat stress (Cornic, 2021). Normally, plants function the best with ranges from 10 to 34°C, with photosynthesis dropping rapidly outside of that range (Cornic, 2021). According to Notten (2015), the best temperature for germination is around 20 to 25°C, not higher. When the plant has already germinated, the plant is recommended to be kept at around 70°F in the day, and 60°F at night, which, converted to Celsius, would be around 21°C in the day, and 16°C at night (Mahr, 2025). It is vital to be careful in winter and on low temperatures, since frost and coldness may kill the tubers (Notten, 2015). The temperature sensitivity *G. superba* L. possesses enables a behavior where in summer, the plant grows, and when winter arrives, it becomes dormant. *Gloriosa superba* L. has adapted its light capture and temperature responses to what it needs, using the efficient C3 photosynthesis to use the tropical light, and reacting to extreme temperatures to ensure survival in the climates where it evolved.

Chapter 3: Biology

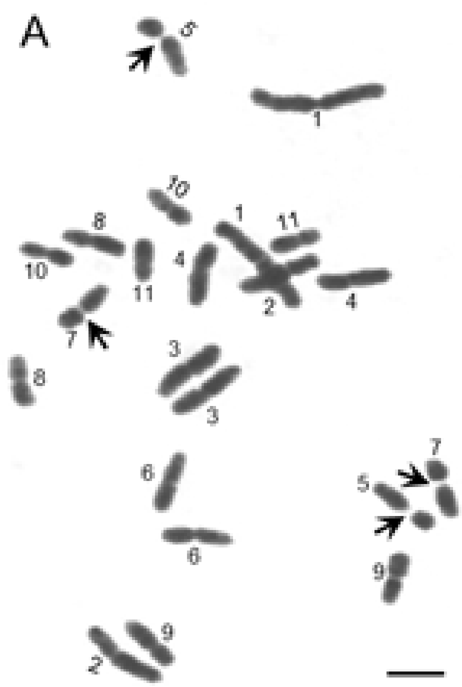
3.1 Chromosome Complement

Gloriosa superba L. has a diploid number of chromosomes, 2n = 22. This means that it normally has 11 pairs of chromosomes (Chacon Pinilla, 2013, p. 189). Additionally, this is corroborated by a chromosome observation in root tip cells of the same species conducted by Amano et al. (2008), where they found that it had a diploid number of 22 chromosomes (p. 116).

In a karyotype analysis conducted on *Gloriosa superba* L., a population of the species was stained with Giemsa, a solution "composed of eosin and methylene blue (azure)" (World Health Organization, 2016, p. 1). This analysis, with the Giemsa staining, generated metaphase plates with a clear chromosome morphology (Jha et al., 2024). The resulting image is seen in Figure 5, where the 11 pairs of chromosomes are visible.

Figure 5

Giemsa-stained metaphase chromosomes



Note. Population of *Gloriosa superba* L. stained with Giemsa. Adapted from "Karyotype analysis on Gloriosa superba using enzymatic maceration and air-drying-based Giemsa, DAPI, and CMA staining techniques," by T. B. Jha, P. Chakroborty, and M. Halder, 2024, *Cytologia, 89*(3), p. 206 (https://doi.org/10.1508/cytologia.89.203).

3.2 Flowering and Pollination

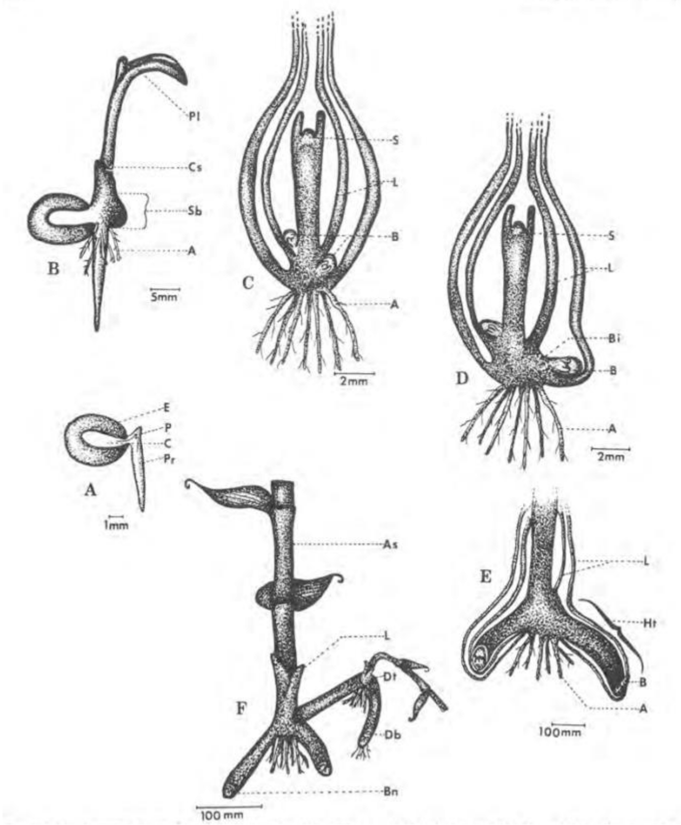
3.2.1 Life Cycle

G. superba L. is an annual climber with a perennial tuberous part (Le Roux & Robbertse, 1994, p. 321). For clarification, a tuberous part, or a tuber, is a specialized storage stem that typically grow below the soil, these have very small buds that may develop into a new plant (Britannica Editors, 2025). In a study investigating the germination and tuber ontogeny of *G. superba* L., Le Roux and Robbertse (1994) find that under suitable conditions, seeds start germinating around 13 days after starting to absorb water. When it starts germinating, the cotyledon elongates but stays embedded in the endosperm for at least 40 days after germination (See Figure 6A) (p. 321).

After germination, the seed starts to have two plumular leaves, these come after the cotyledons and are the true leaves, responsible for future photosynthesis (Figure 6B). Following this, there is a dormant bud with leaf bases, which is where the shoot will originate from (Figure 6C). Subsequently, the basal node elongates, which will later become a tuber (Figure 6D). Next, there is a new tuber with leaf bases and more buds at the tip, ready for more shoots to arise (Figure 6E). Finally, the decaying tuber is replaced by a developing one, along with new buds that will produce the seasonal shoots (Figure 6F) (Le Roux & Robbertse, 1994). From these tubers, shoots arise. These become ephemeral climbing stems that die back and the end of growing season (Daniels et al., 2020, p. 1138). The climbing stems may reach up to 4 meters of longitude and grow annually (Padmapriya et al., 2015, p. 44).

Figure 6

Developmental stages of G. superba L.



Note. A. Germinating seed with cotyledon embedded in endosperm (C, cotyledon; E, endosperm). B. Seed with two photosynthetic leaves with a base of stem increasing in width (Pl, plumular leaves; Sb, stem base). C. Transverse section of the stem base that shows a dormant bud and a shoot surrounded by two leaf bases (S, shoot; L, leaf bases; B, bud; A, root). D. A transverse section of the stem base showing the elongation of a basal node to give rise to a tuber. (S, shoot; L, leaf bases; B, bud; Bi, basal node; A, root). E. Transverse section of the tuber, covered by leaf bases, with buds lodged at the extreme tips of the tuber. (L, leaf bases; Ht, tuber; B, bud; A, root). F. The decaying parent tuber of the previous season with dormant buds that have become active to give rise to the new season's aboveground and perennial parts. (As, aboveground stem; L, leaf base; Dt, decaying tuber; Db, developing bud; Bn, dormant new seasonal bud). From “Tuber ontogeny, morphology and vegetative reproduction of *Gloriosa superba* L.,” by L. G. Le Roux and P. J. Robbertse, 1994, *South African Journal of Botany, 60*(6), p. 322.

3.2.2 Phenology

The plants of *G. superba* L. produce many flowers, around 6 per branch, and when cultivated, can produce from 7 to 58 flowers in a year. There is a suggestion that the flower openings are sequential but is not clear due to a scrambling nature of its growth form. These flower openings are linked with their orientation to enhance pollinator contact. Although not a calendar study, the patterns of flower opening and pollinator visits form a phenological sequence that may be used for reproductive success (Daniels et al., 2020). In a phenological study carried out by Jain and Rai (2014), the flowering behavior is identified, noting that in a district in India, flowering starts in August and ends in October. Also, they mention that the fruiting behavior starts in November and finishes in January (p. 3).

3.3 Reproductive Biology

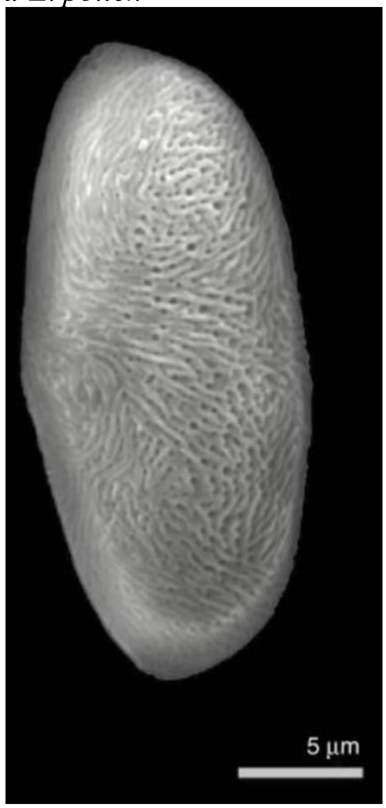
3.3.1 Pollen

Pollen grains of *G. superba* L. are oblate monads with a length of 22 ± 2.8 µm. They have a surface covered in overlapping ridges, also called a reticulate or regulated outer layer, as seen in Figure 7 (Daniels et al., 2020, p. 1142). As stated by Daniels et al. (2020), they have a well-developed pollenkitt[1] which enables clumps of pollen to form (p. 1142).

[1] Pollenkitt: bioadhesive than enables pollen to form clumps.

Figure 7

Electron micrograph of G. superba L. *pollen*



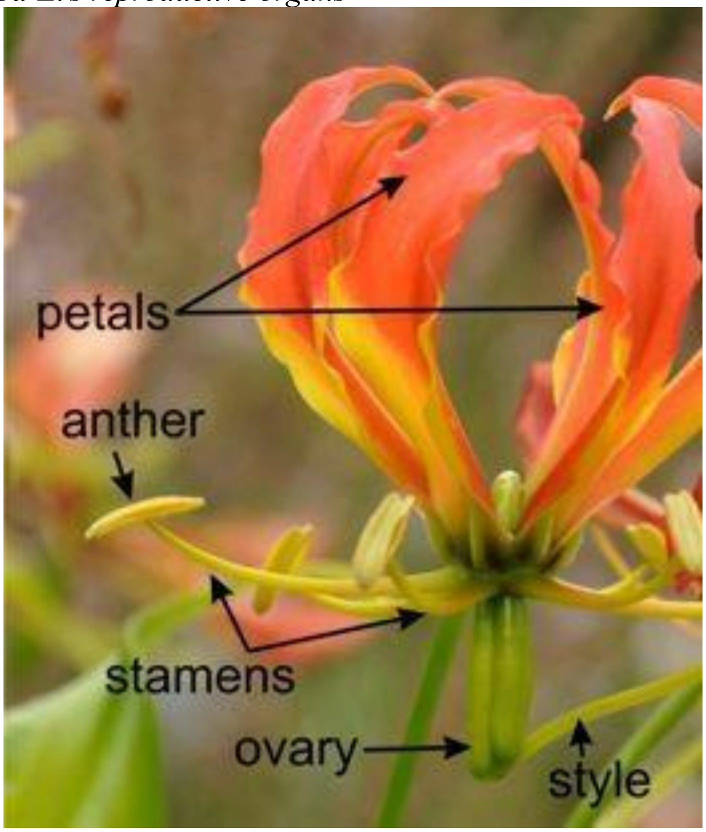
Note. Pollen grain treated with carbon disulphide to remove pollenkitt. Adapted from “Flower orientation in Gloriosa superba (Colchicaceae) promotes cross-pollination via butterfly wings,” by R. J. Daniels, S. D. Johnson and C. I. Peter, 2020, *Annals of Botany, 125*(7), p. 1143 (10.1093/aob/mcaa048) Copyright 2020 by Oxford University Press

3.3.2 Sexuality

G. superba L. is self-compatible, but needs pollinators to produce seeds, specifically butterflies. The flowers are hermaphroditic, meaning they have male and female organs (Daniels et al., 2020, p. 1137). The male organ is the stamen, with a filiform shape, sometimes flattened. They are 10 to 45 mm long. The part with the pollen, the anther, goes from straight to curved and is 5.5 to 15 mm. The female organ is the pistil, composed of the style and ovary. The ovary is 4 to 13 mm long and 1 to 5 mm wide, while the style is 9 to 50 mm long (Hoenselaar, 2005). The different parts are depicted in Figure 8.

Figure 8

Diagram of G. superba L.*'s reproductive organs*



Note. Depiction of *G. superba*'s reproductive organs. Adapted from *Gloriosa superba*, by A. Notten, 2015, South African National Biodiversity Institute (https://pza.sanbi.org/gloriosa-superba)

3.3.3 Anthesis

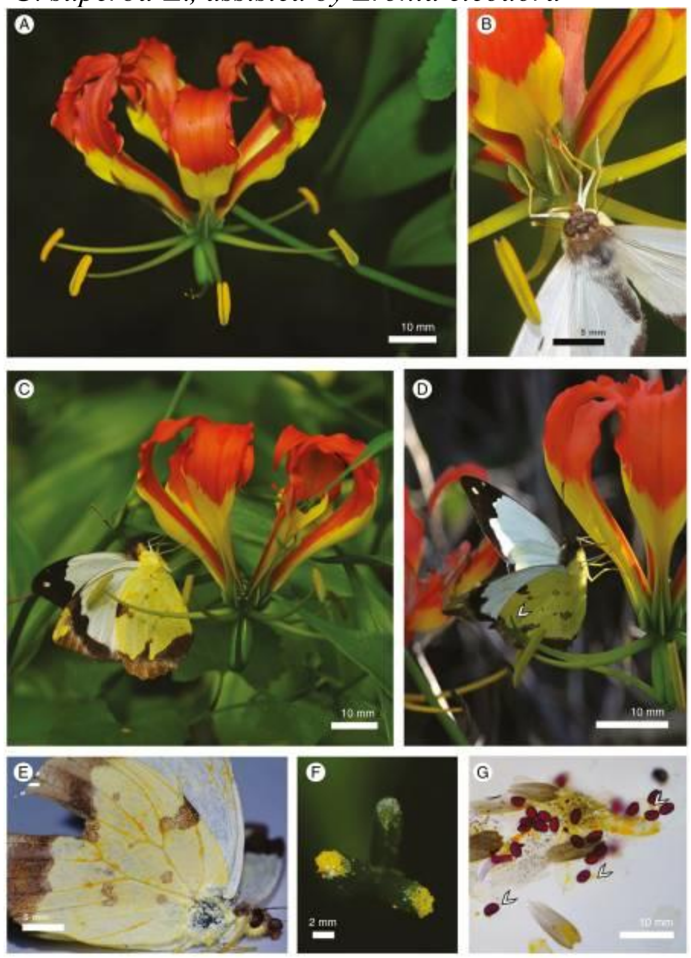
Flower opening, or anthesis, normally occurs in morning hours. In a study of the species' reproductive biology, Selvarasu and Kandhasamy (2012) found that the percentage of bud opening and anther dehiscence was at its maximum at 9:30 AM. This coincides the most efficient release of pollen with the best receptivity (p. 5). Also, the average of anthesis duration (from bud to spent flower) is 21.10 days (Selvarasu & Kandhasamy, 2012, p. 5). When in anthesis, the colors change depending on the stage, going "from light green (bud-opening) to crimson at the tip, yellow towards the mid-perianth and green at the base (stigma-receptive), and finally it turns entirely crimson (late post-pollination)" (Daniels et al., 2020, p. 1138).

3.3.4 Pollination and Potential Pollinators

G. superba L. is self-compatible but still depends strongly on pollinators. Primarily, the species depends on butterflies, especially *Eronia cleodora*, accounting for more than 90% of the visits. In Figure 9, the process and mechanism in which *Eronia cleodora* helps pollinate *G. superba* is shown. The butterflies are attracted by the nectar produced by the plant and while feeding, brush their wings with the anthers (see Figure 9D), collecting pollen that will later be brought to another plant. Additionally, the styles are oriented toward open areas to attract pollinators (Daniels et al., 2020, p. 1137). According to a study conducted by R. J. Daniels et al. (2020), 93.6% of 79 butterfly visits were by *Eronia cleodora,* with 4 visits from *Papilio demodocus* and one from *Papilio Dardanus*. All these butterflies were seen primarily in the continental Africa region (p. 1142).

Figure 9

Pollination process of G. superba L.*, assisted by Eronia cleodora*



Note. A. Consists of one hermaphrodite and five male functional pollination units. B. *Eronia cleodora* positioned between stamens while probing nectar pouch. C. Anthers deposit pollen on the underside of butterfly's wings. D. Contact between anthers and wing (see arrow). E. Butterflies have large amounts of pollen primarily along wing veins. F. Pollen on female reproductive organ. G. Pollinated female organ showing pollen, wing scales, and pollenkitt of each pollen grain (see arrows). From "Flower orientation in Gloriosa superba (Colchicaceae) promotes cross-pollination via butterfly wings," by R. J. Daniels, S. D. Johnson and C. I. Peter, 2020, *Annals of Botany, 125*(7), p. 1143 (10.1093/aob/mcaa048) Copyright 2020 by Oxford University Press.

3.3.5 Fruit Development and Seed Set

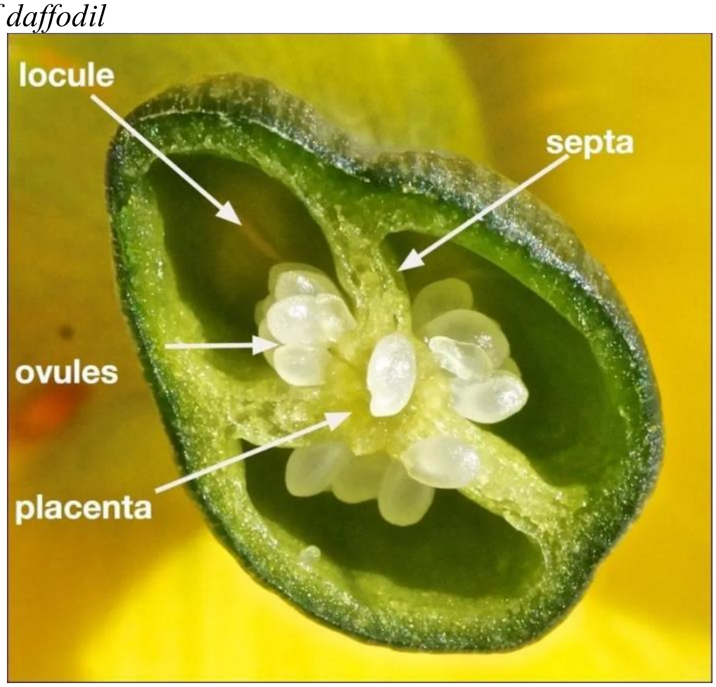
When trying different methods, there is a big difference in seed yield. Although the plant's shape favors cross-pollination, self-pollination gives better results. Controlled self-pollination, or idiogamy (between flowers of the same plant), gave a yield of 9.20 g per plant and 681.73 kg per hectare, compared to a 4.31 g per plant and 319.26 kg per hectare in naturally pollinated ones (Raina & Gupta, 1999, p. 175). The fruits are capsules, they can be 37 to 50 mm long and can have a diameter of 10 to 14 mm (Hoenselaar, 2005). The seeds are fleshy, with a subglobose or ovoid shape (Timberlake, 2010, p. 176). Each fruit may have from 30 to 77 seeds (Daniels et al., 2020, p. 1138).

3.3.5.1 Ovule Development

The ovary of *G. superba* L. is trilocullate, meaning it has three locules or cavities (see Figure 10). In each locule, there is about 30 ovules. But, not all of them area easily fertilized into a seed, which could be attributed to a potential partial incompatibility (Le Roux & Robbertse, 1997, p. 196).

Figure 10

Trilocullate ovary of daffodil



Note. Three locules containing ovules in a daffodil ovary, meaning it is trilocullate. From "Ovules and Placentas," by Tree Guide UK, 2026, *Ovules and Placentas* (https://www.treeguideuk.co.uk/ovules-and-placentas/).

3.4. Ecophysiology

3.4.1 Germination

G. superba L. can be spread by seeds or divisions of the tubers. Germination is erratic, happening in 2 weeks to 3 months, while some seeds can stay dormant for 9 months (Notten, 2015). This erratic and poor germination is due to the almost impermeable outer seed coat (sarcotesta), which restricts water uptake. Seed germination can be increased to an 85% if small incisions are made on the sarcotesta and are soaked for 24 hours (Mahajan et al., 2023, p. 15). This is due to a better imbibition since the sarcotesta does not block water completely. Additionally, *G. superba* seeds remain viable up to 2 years after harvesting them (Mahajan et al., 2023, p. 25).

Chapter 4: Propagation and Management

4.1 Natural Regeneration

In the wild, *G. superba* rarely reseeds successfully because its seeds have a deep physical dormancy. Their thick sarcotesta and tegmen layers are very impermeable to water, so their natural germination is extremely long and uneven, taking around 6 to 12 months (Mahajan et al., 2023). Seed dormancy is a significant barrier to natural regeneration in wild population (Mosoh et al., 2024). Dehiscent capsules eject seeds, but without dormancy break (through scarification or soaking), very few germinate naturally. Seed dormancy can be overcome by mechanical scarification and 24-hour soaks, where incisions through the impermeable layer are made and then followed by a long soak in water to facilitate water imbibition. This procedure could raise germination up to >85% (Mahajan et al., 2023). However, under field conditions, these treatments are not very practical. Apart from seed dormancy, over-collection and habitat destruction have declined substantially the population of wild *G. superba*. Additionally, there is little to no data on how long seeds persist in soil or on wild seedling survival.

4.2 Vegetative Regeneration

G. superba regenerates clonally from its underground rhizomatous tubers. The rootstock is horizontal and frequently forked (National Parks Board, 2026). Each dormant tuber can produce one new vine and up to two daughter tubers annually under good conditions (Mahajan et al., 2023). When cultivating, growers divide healthy tubers in half to increase their planting stock, but this should be done sparingly, no more than once every 3 years, since the tubers are very brittle. This division is normally done in fall or early spring when plants are still dormant (Mahr, 2025). While effective, multiplication is slow since one mature plant yields few offshoots per year.

Figure 11

Rhizomatous tubers of G. superba

Note. Elongated tubers of *Gloriosa superba.* From "Gloriosa lily, Gloriosa superba," by S. Mahr, 2025, *Wisconsin Horticulture* (https://hort.extension.wisc.edu/articles/gloriosa-lily-gloriosa-superba/).

4.3 Nursery Propagation

In nurseries, *G. superba* can be raised from seed or tuber pieces. To raise from seeds, they require scarification or removal of the dry fleshy coat. Mechanical scarification, nicking the seed coat, and soaking can give a germination of >85%, as mentioned before (Mahajan et al., 2023). To plant seeds, it is recommended to sow the already treated seeds in small pots with a well-drained potting mix (peat-based mix with sand). These should be at most one inch deep and kept uniformly moist and warm (25°C). Germination is slow and may take several months, if it happens. (Hassani & Lagattuta, 2024; Mahr, 2025). When planting tubers, healthy tubers should be selected, each weighing 40 to 60 grams (Tamil Nadu Agricultural University, 2015b). Tubers can be lifted after the plants flower and before first frost to dry and store over the winter, when planted, new growth is seen emerging slowly in late spring or early summer, with rapid growth after weather warms up. These should be planted in rich, well-drained soil in a horizontal position, 2 to 4 inches deep.

Additionally, they should be kept evenly moist and provided with dilute fertilizer monthly when leaves appear. A trellis should be placed for the vines to climb but shouldn't be handled or redirected too much since the stems are easily damaged (Mahr, 2025).

4.4 Cuttings

Stem-cutting propagation of *G. superba* is uncommon and not supported by formal studies. The plant's brittle stems and limited natural rooting tendency make cuttings unreliable. Horticultural sources note that growers almost always use tuber division instead (Mahr, 2025). Given the lack of procedures and evidence of success, it is not recommended as a primary method to propagate. Tuber division or seed propagation should be applied as methods.

4.5 Planting

Field planting of *G. superba* should have a site full sun or light partial shade and rich, loamy, well-drained soil. Tubers should be placed horizontally 2 to 4 inches deep (Mahr, 2025; National Parks Board, 2026). Plants should be spaced 15 to 30 cm apart in rows, with 1.8 m between rows. It was found that closer in-row spacings maximized yield per area, while wider spacing increased yield per plant (Sathish, 2000). A practical guideline of 20 cm apart in rows can be used. A thorough watering is best, without waterboarding, along with a thin-wire or net trellis for support as vines develop. Planting the tubers too deep should be avoided, as it greatly delays emergence.

4.6 Cultivation

The plant thrives in warm, humid environments with cool nights. Ideal day and night temperatures are around 21°C and 15°C, accordingly (Hassani & Lagattuta, 2024). When wanting to cultivate, there are many pests and diseases to watch for. Common problems include leaf blight (*Alternaria alternata*), root/tuber rot (*Macrophomina phaseolina*), and sap-sucking insects like aphids. These can be identified by symptoms like brown rings on leaves or stems, yellowing, and wilting. Viral mosaics can also be present, as they can be transmitted by aphids. To prevent or treat these problems and ensure a good cultivation, the use of preventive fungicide is recommended. The tubers can be dipped in *Pseudomonas fluorescens* for 20 minutes to reduce the rot, and in the field, *Bacillus subtilis* can be sprayed on 30 and 60 days after planting to suppress leaf blight. Aphids should be monitored, and outbreaks can be treated with insecticidal soap (Tamil Nadu Agricultural University, 2015a). Infected plants should be removed and destroyed as soon as possible. For optimal cultivation, regular scouting, field hygiene, and use of biocontrol agents is recommended.

4.7 Fertilizing

A fertilizer balance favoring nitrogen will enhance vine growth and bloom. Phosphorus and potassium support tuber development. A recommend dose is 120 kg N, 50 kg P_2O_5, 75 kg K_2O per hectare. All the P_2O_5 and K_2O along with a third of the N should be applied as a basal dose, and the rest of the N should be given 6 to 8 weeks after planting. Additionally, micronutrients like Zn or Fe may be needed in depleted soils (Phatak & Hegde, 2014). Experiments in India confirm this dose produces high yield. When dealing with potted plants, a monthly dilute complete fertilizer is best. However, over-fertilization, especially of N, can induce excessive foliage at the expense of flowers (Hassani & Lagattuta, 2024). Application of farmyard manure has also shown higher yields of capsules per plant, seeds per capsule, and tubers (Phatak & Hegde, 2014). Finally, *G. superba* is mycorrhiza-responsive, meaning that there is a symbiotic relationship with the mycorrhizal fungus, increasing the colchicine content of the plant. Because of this, the use of microbial biofertilizers like the mycorrhizal fungus should be considered (Pandey et al., 2014).

4.8 Growth Stages

Seedlings break dormancy 1 to 9 months after sowing, often aided by scarification (Mahajan et al., 2023; National Parks Board, 2026). Tubers sprout around 6 weeks after planting. Growth is initially slow, vines coil onto supports as the lengthen. Mature vines produce their first flowers in summer. Floral initiation occurs when plants have formed 30 to 50 leaves (Phatak & Hegde, 2014). Flowers then emerge and open quickly. Petals are yellow at the base and become red-tipped (Hassani & Lagattuta, 2024). Flowering may continue for several months under favorable conditions. Pollinated flowers form greenish loculicidal capsules. These pods mature and turn brown. After drying, capsules explosively split, releasing clusters of black seeds (National Parks Board, 2026). As shoots mature, tubers enlarge underground. Vines and leaves yellow and die back in late season, signaling dormancy.

Figure 12

Blooming Gloriosa superba

Note. Flower from *G. superba.* From "Gloriosa lily, Gloriosa superba," by S. Mahr, 2025, *Wisconsin Horticulture* (https://hort.extension.wisc.edu/articles/gloriosa-lily-gloriosa-superba/).

4.9 Fruiting

The plant's fruits are dry, dehiscent and loculicidal capsules. Each of the three locules contains around 20 seeds. Each fruit contains 30 to 77 seeds (Daniels et al., 2020). Capsule dehiscence is explosive, scattering seeds nearby. Seed maturity coincides with the fruit's browning. In cultivation, gently harvesting ripe pods before they open prevents seed loss. Optimal harvest times for seed production is poorly quantified, but pods can be netted to capture seeds.

Figure 13

Oblong fruits from G. superba

Note. From "Gloriosa lily, Gloriosa superba," by S. Mahr, 2025, *Wisconsin Horticulture* (https://hort.extension.wisc.edu/articles/gloriosa-lily-gloriosa-superba/).

4.10 Harvesting

To harvest tubers, they should be dug out after the plant flowers and before first frost. These should be carefully cleaned, as they are very brittle. They can be stored in a cool location. Alternatively, they can be stored in containers in-ground (Mahr, 2025). This provides year-round planting stock. To harvest flowers, the stem should be cut after 1 to 2 flowers have opened, replacing in water or dry placing immediately. From a tight bud to withering, it takes 2 weeks, so they last 3 to 5 days completely bloomed (Notten, 2015). To harvest seeds, it is necessary to wait for the fruit to turn brown and start to split, collecting them to prevent seed loss. These capsules can either be hung in paper bags on the plant or picked and dried indoors. After drying, the fruit can be broken open and the seeds can be removed. After harvesting, diseased plant debris needs to be disposed, preferably burned. If the disease was too severe, it is best to avoid re planting in the same spot of soil. To avoid rotting, tubers should be dipped in fungicide (Tamil Nadu Agricultural University, 2015a).

4.11 Pruning and Replanting

Pruning of shoots is generally unnecessary. When the stems die back after the flowering period, they can be cut back down to ground level. Foliage and stems should be left in place while they are still green because this is the period where the plant is storing energy for its tuber. Removing any dead foliage may help reduce disease. In regions with cold winters, digging and storing tubers helps dormancy. Alternatively, if the plant is potted, it should be brought indoors (Hassani & Lagattuta, 2024). When replanting tubers, they should be inspected. Shriveled or rotten ones need to be discarded. They need to be replanted in early spring using the protocols already mentioned. When replanting, tubers can be divided into rhizomes of 40 to 60 grams, but only every 3 to 4 years (Mahr, 2025). These divisions should be planted immediately.

Chapter 5: Market and Uses

5.1 Economic Importance and Market Overview

Gloriosa superba is mainly grown for its medicinal alkaloids. India leads the global trade in *G. superba*, reflecting its status as a top exporter of medicinal herbs. In 2017-18 India's herbal exports, of all species, reached USD 330.18 million, with Tamil Nadu (an Indian state) alone providing around 40% of that value (Periyasamy & Mohan, 2025). *Gloriosa superba* cultivation is a high-value cash enterprise for farmers. Profits per acre are very high, having even up to a profit of ₹15.8 lakhs per acre (Logesh et al., 2024). This value is very high compared to many crops. It also has an ornamental value, since it is the state flower of Tamil Nadu as well as the national flower of Zimbabwe (Periyasamy & Mohan, 2025). This adds cultural significance, but the actual market value comes from the pharmaceutical demand for colchicine, the alkaloid present. It is normal for farmers to earn Rs. 2000-3000/kg for seeds. However, this is a fluctuating price, as can be seen with the drop in price of Rs. 2000/kg in 2021 to 1200/kg in 2022 (Periyasamy & Mohan, 2025).

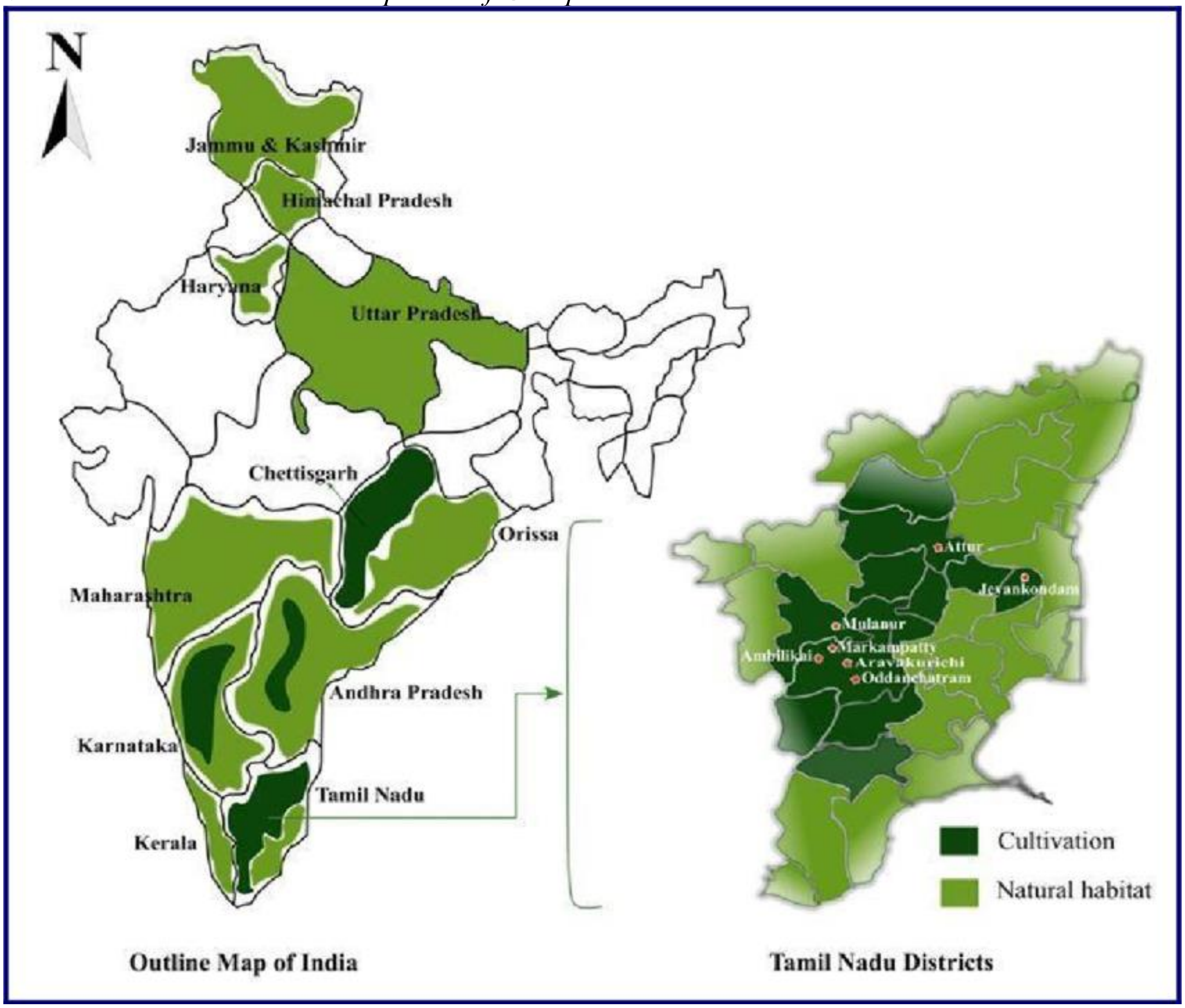
5.2 Production and Global Distribution

5.2.1 Major Producing Countries

India is by far the largest producer of *G. superba*. Almost all commercial cultivation occurs in South India, especially the districts Dindigul, Tiruppur, and Karur in the state of Tamil Nadu (Periyasamy & Mohan, 2025). There was a reported cultivation of this lily in Tamil Nadu of around 6,377 hectares (Logesh et al., 2024). There are reports of small-scale cultivation in other Indian states like Andhra Pradesh (Tamil Nadu Agricultural University, 2025). There are some wild populations in Africa, in countries like Ethiopia and Tanzania (Plants For A Future, 2024). The distribution of cultivation and habitat places of *G. superba* in India is shown below, zooming into Tamil Nadu to show its specialty in this plant.

Figure 14

Natural habitat and cultivation places of G. superba in India



Note. From "Gloriosa superba L: A critical Review of Recent Advances," by K. Gopinath, 2020, *Abasyn Journal Life Sciences, 3*(2), p. 49 (http://ajlifesciences.com/article.php?paperID=35).

5.2.2 Production Volumes and Yield

In Tamil Nadu, *G. superba*'s yield has been calculated as about 0.40t/ha (Logesh et al., 2024). Converted, this corresponds to roughly 0.16t/acre. However, these yields vary widely with climate. Under good conditions, it can be 400-600kg/acre but can go as low as 10-200kg/acre in poor climate (Periyasamy & Mohan, 2025). Area and production have been steadily rising in major districts (Logesh et al., 2024). It is important to note that profitability improves in the second or third year of cultivation as plants mature (Periyasamy & Mohan, 2025). Beyond Tamil Nadu, there is a lack of reliable volume or yield data.

5.2.3 Value to Local Economies

The Gloriosa lily is a high-value cash crop in its growing regions. Farmers invest in expensive planting stock (rhizomes) but regain costs through premium seed prices. As explained before, per-acre profits are much higher than those of staple crops. Studies note that farming of *G. superba* significantly contributes to the agricultural economy and has the potential to improve the livelihoods of farmers (Logesh et al., 2024). Many farmers from the Dindigul district in India have shifted to growing this plant over the last 20 years because of these reasons (Periyasamy & Mohan, 2025).

5.3 Trade and Market Structure

5.3.1 Export vs Domestic Markets

The *Gloriosa* seed trade is heavily export oriented. Commercial buyers are mostly pharmaceutical firms abroad extracting colchicine. In Tamil Nadu, around d80% of the annual harvest (export-grade seeds) is sold to these processors, often under contract (Periyasamy & Mohan, 2025). Domestic consumption is minor by comparison, with very few Indian companies in a limited local market for the seeds.

5.3.2 Market Chain

The supply chain is short but segmented. Farmers grow *G. superba* on small plots and sell seeds at harvest. Collecting agents (middlemen) or "promoters" visit villages during harvest season to buy seeds. Some farmers organize into cooperatives (Farmer Producer Organizations) or use contract farming with buyers (Logesh et al., 2024). The seed lots are then delivered to processing companies, mostly pharmaceutical extractors, which clean and extract colchicine. The transaction terms vary, some buyers offer advance payments or price guarantees, while others pay spot prices at collection (Tamil Nadu Agricultural University, 2025).

5.3.3 Supply and Demand Trends

Global demand for *G. superba* is driven by its drug colchicine, industry reports indicate rising interest due to new therapies, but also note supply constraints. India's production has grown to meet demand (Periyasamy & Mohan, 2025). Exact world demand data is scarce. There is evidence that pricing pressure is a major issue, farmers express a price fluctuation that acts as their top marketing constraint (Logesh et al., 2024). On the side of demand, colchicine demand remains stable in the pharmaceutical market.

5.4 Products

5.4.1 Raw Plant Material

The primary raw products are dried ripe seeds and occasionally dried tubers. Seeds are harvested from the pods in winter, sun-dried, and sold in bulk (Paroda et al., 2013). Each fruit contains around 70-100 seeds. The tuber is dug up only at the end of crop life and dried, this is because it contains colchicine but at much lower concentration than seeds (Fern, 2026). In trade, seeds have the highest prices due to their high alkaloid content. Roots and leaves have minor market value.

5.4.2 Processed Products

The key value-added product is colchicine extracted from *G. superba* seeds and tubers. Extraction happens by use of super critical fluid extraction technology (SCFE). This works by using pressurized gases, like carbon dioxide, heated above their critical point to act as a solvent, with liquid-like density and gas-like diffusion. This extracts compounds by dissolving them, then separating by reducing pressure to evaporate the gas (Balkrishna et al., 2019). Other less common products include herbal extracts used in folk medicine.

5.5 Uses

5.5.1 Medicinal Uses

In traditional medicine *Gloriosa superba* has a very broad range of uses. The tuber and seeds contain colchicine and other alkaloids, which have been used in Ayurvedic medicine in various parts of Africa and Southeast Asia. The plant is used to cure arthritis, gout, rheumatism, inflammation, ulcers, bleeding piles, skin diseases, leprosy, impotency, and snakebites (Jana & Shekhawat, 2011). It has also been known to be used as a laxative and an alexiteric (Plants For A Future, 2024). However, this medicine is rarely used without expert supervision due to toxicity.

5.5.2 Toxicity and Risks

Every part of *G. superba* is highly poisonous because of colchicine (Plants For A Future, 2024). Ingestion of tubers or seeds can cause severe gastrointestinal distress, organ failure, and death. The plant has even been used for homicide and suicide (Gunasekaran et al., 2019). Common symptoms of poisoning include nausea, vomiting, and diarrhea (Mayo Clinic Staff, 2026). The lethal dose for humans is 0.8mg/kg, and upon ingestion, the effects are quick. Case fatality rates from South India and Sri Lanka reach as high as 15% (Gunasekaran et al., 2019).

5.5.3 Other Uses

Beyond medicine, the plant is also used ornamentally and culturally. The showy flowers and ease of growth as a vine make it popular in gardens worldwide. It is also used as a cut flower and potted plant in Europe and Asia (Fern, 2026). Additionally, because of its status as the state flower of Tamil Nadu and national flower of Zimbabwe, it holds cultural value (Periyasamy & Mohan, 2025).

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