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Review Article

Glory Lily (*Gloriosa superba* L.) - A Review

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ABSTRACT

Gloriosa superba is an herbaceous or semi-woody climber with v- shaped tubers. The plant is highly valued for its medicinal properties, more importantly for the treatment of cancer related diseases, arthritis, gout, rheumatism and impotency, containing the alkaloids, colchicines and colchicosides. Colchicine also acts as an anti-mitotic agent by inhibiting mitotic cell division. Thiocolchicoside (TCC), is a semi-synthetic derivative of naturally occurring colchicoside with anti-inflammatory and analgesic effects. The fascinating bright coloured flowers and hercogamous nature favours for cross pollination. Development of genotypes with improved seed yield, alkaloid content and field resistance to major pests and diseases are of paramount importance for catering the needs of phytopharmaceutical industries. Being a climber, glory lily requires support in the form of trellies or standards. Rapid multiplication of microtubers produced from the seed material has reduced the pressure on the dependency on wild harvested tubers. The present review focuses on the botany, medicinal uses, cytogenetics, floral biology, breeding methods, cultivation, post harvest technology and phytochemistry of glory lily.

Keywords: *Gloriosa superba*, colchicine, tubers, cross pollination, phytochemistry.

INTRODUCTION

Gloriosa superba L. is a perennial climber, extensively scattered in the tropical and sub-tropical parts of the India, including the foothills of Himalayas. This spectacular lily is native of Africa and is the national flower of Zimbabwe. In India, it is widely distributed and is the state flower of Tamil Nadu. *Gloriosa* derives its name from the word 'gloriosus', which means handsome and *superba* from the word 'superb' means splendid or majestic. The fondness for floral beauty has also placed *Gloriosa* as a pot plant in gardens [10]. It is known as 'Malabar glory lily' in English, 'Kalihari' in hindi, 'Agnisikha' in Sanskrit. *Gloriosa superba* is an important medicinal plant is used to treat cancer related diseases, arthritis and gout. Earlier than 1980, the tubers were indiscriminately harvested from the wild and utilized for medicinal applications. As a result of continuous over-exploitation of tubers from wild, the species was on the verge of extinction and was one of the endangered species among the most valued medicinal plants. Until this period, upto 75% of raw material required by pharmacies and drug manufacturers was fulfilled only from wild. *Gloriosa superba* has been reported to occur naturally in Africa, India and South eastern Asia and distributed widely throughout the tropics. It has natural occurrence through much of tropical Asia including: India, Sri Lanka, Malaysia and Burma. It occurs in thickets, forest edges and boundaries of cultivated areas in warm countries upto height of 2530 m. In temperate countries, *Gloriosa superba* is grown as an ornamental in conservatories and greenhouses [19]. Places known for its distribution are Nasik, Ratnagiri, Savanthwadi (Maharastra); Uttara Kannada, Hassan, Chikmangalur, Coorg, Mysore (Karnataka); Cannanore, Palakkad, Trivandrum (Kerala); Tamil Nadu and Goa. Tamil Nadu has the largest area under glory lily cultivation (upto 6000 acres) spread over seven districts viz., Karur, Tirupur, Dindigul, Salem, Ariyalur, Perambalur and Nagapattinam and holds monopoly in production of glory lily seeds with an annual production of over 600 -700 tonnes.

Medicinal uses

In the Indian Systems of Medicine, the tubers are used as tonic, antiperiodic, antihelmenthic and also against snake bites. In 1992, Duke has reported the abortifacient action of the plant rhizome. It is used as poultices to relieve neuralgia, used in topical applications to treat arthritic conditions, swellings of the joints, sprains and dislocations [22]. The tuber is traditionally used for the treatment of bruises and sprains, colic, chronic ulcers, hemorrhoids, cancer, and leprosy and also for inducing labour pains. Paste of the tuber is externally applied for parasitic skin diseases. The tuber, pods and leaves were used to treat infections of guinea-worms, schistosomes (causing bilharzia), roundworm, tapeworm, liver fluke and filarial [7]. Soup made from leaf or tuber sap after due processing are administered to women suffering from sterility, delayed puberty, delayed childbirth and menstrual problems. Leaf juice, unripe fruits mixed with

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butter, and tuber macerate has been reported to kill head lice. It has to be mentioned with caution that glory lily tuber is extremely poisonous and causes fatal death if consumed [9]. Seeds and tubers contain valuable alkaloids viz., colchicine and colchicoside as the major constituents, which is used to treat gout and rheumatism. Due to the action of colchicoside on spindle fibre formation during cell division, the plant has been identified as a potential anti cancerous drug.

Botany

Stem: Climbing, sometimes erect herb up to 4 m long; stem annual, glabrous and sparsely branched [23]

Tuber: Perennial, horizontal, abruptly bent into a V or L shape and fibrous.

Leaves: Occurs in whorls of 3–4, opposite or alternate, simple, sessile; blade ovate to lanceolate, 6–15 cm x 1.5–4 cm, base obtuse, apex of upper leaves with or without 1 –2 cm long tendril, parallel-veined.

Flowers: The flowers are large, axillary and solitary, with pedicels which are reflexed near tip. They are incomplete, ebracteolate, perfect, regular, hypogynous, acropetal and cyclic. Flowers contain nectariferous structures.

(a) Perianth: Petaloid, persistent, tepals six, three traced free with strongly crinkled and waved margin, narrow and linear in shape, reflexed, greenish at first, then yellow, passing through orange and scarlet to crimson. They are arranged in valvate and induplicate aestivation.

(b) Androecium: Stamens six, hypogynous, anther linear, dorsifixed, versatile and dehisce extrorsely to shed bright yellow pollen in abundance

(c) Gynoecium: Superior ovary, tricarpellary, syncarpus, monolocular, numerous ovules on parietal placents, style sharply deflexed at a right angle from the ovarian axis, stigma trifid.

Fruit: A loculicidal, oblong capsule 4 –6 cm X 1–2 cm containing upto 20 seeds.

Seed: Seeds ovoid, 4–5 mm in diameter, surrounded by a fleshy, red sarcotesta.

Cytogenetics

Gloriosa superba is considered as a single highly variable species. *Gloriosa* is monobasic with a genetic base x =11. Out of the 10 elemental species, *Gloriosa superba*, *G. lutea* and *G. plantii* are diploids (2n=22), *G. carsonii*, *G. virescens* and *G. richmondensis* are tetraploids (2n=44) and *G. rothschildiana*, *G. latifolia* and *G. magnifica* are octoploids (2n=88). In general, octoploid species are comparatively short statured and constitute a medium group of plants. The chromosome number is 2*n* =14, 22, 33, 44, 66, 77, 84, 88, 90. The important species found in India are *Gloriosa superba* and *G. rothschildiana* [28]. Karyomorphology of two life-forms of *Gloriosa superba* L. was analyzed. The basic chromosome number was 22 in both life-forms and no chromosome polymorphism was recognized. Variations were noted in individual chromosome lengths, total length of the haploid complements, TF%, centromeric types and karyotypic formula. The karyotypic class was 2A symmetric type which indicated the primitiveness of this species [3].

Species Status

There are ten accepted species of *Gloriosa*, ignoring hybrids, varieties and cultivars. They are;

Gloriosa aurea Chiov.
Gloriosa baudii (A.Terracc.) Chiov.
Gloriosa flavovirens (Dammer) J.C.Manning&Vinn.
Gloriosa lindenii (Baker) J.C.Manning & Vinn.
Gloriosa littonioides (Welw. ex Baker) J.C.Manning & Vinn.
Gloriosa modesta (Hook.) J.C.Manning & Vinn.
Gloriosa revoilii (Franch.) J.C.Manning & Vinn.
Gloriosa rigidifolia (Bredell) J.C.Manning & Vinn.
Gloriosa sessiliflora Nordal & Bingham
Gloriosa superba L.

Floral biology

Glory lily is a cross pollinated species and the fundamental information including anthesis, stigma receptivity, pollen viability and fertility have been reported in various crop improvement programme.

Flower bud development

In 1993, Mamatha identified nine stages of flower bud development. It took 17 days for a bud to reach to the stage of anthesis. In 2012, according to Anandhi and Rajamani, five stages of flower development *viz*., bud initiation, bud opening, pre-anthesis, anthesis, post pollination stage was reported. In all these stages, the flower colour changed during each stage of flower development. The perianth lobes at the bud opening stage were light greenish in colour followed by the stigma receptive stage which was characterized by perianth lobes that were scarlet red at the tip, yellow in the middle and greenish towards the base. Post pollination stage was characterized by the upper half of perianth lobes being scarlet red and the lower portion being yellow coloured. Lastly, the perianth lobes turned entirely into scarlet red.

Anthesis

Anthesis was observed to occur earlier than 7.30 am to 9.30 am with 40 per cent of the flower opening by 7.30 am, 50 per cent by 8.30 am and rest 10 per cent by 9.30 am. In 1989 Mamatha observed that the peak period of anthesis in *Gloriosa superba* was between 8.30 to 10.30 am In *Gloriosa*, the flowers bloomed during morning hours after the onset of sun. The bud opening started from 6.30 to 7.30 am and increased gradually after reaching the peak at 9.30 am and there after started declining and reached the minimum between 9.30 to 10.30 am, beyond which no flowers opened [1].

Anther dehiscence

Anther dehiscence in *Gloriosa superba* takes place between 8.30 to 10.00 am [9]. It was observed that on the day of anthesis, there was no anther dehiscence. One day after anthesis, the anther started dehiscing earlier than 7.30 am to 9.30 am. On an average, five per cent of the anthers dehisced before 7.30 am, 70 per cent before 8.30 am and another 25 per cent by 9.30 am [18]. In 2012, according to Anandhi and Rajamani, the anther dehiscence started from 6.30 am and reached the peak at 9.30 am and thereafter started declining and reached the minimum at 10.30 am. This indicated that glory lily is photosensitive and anthesis corresponded to the intensity of sunlight falling on the plants. Thereupon (after 10.30

am), as the intensity of sunlight is more, the anthesis slowed down.

Receptivity of stigma

In *Gloriosa superba*, 97.50 per cent pod set was observed in flowers which were pollinated on the day of anthesis, indicating the maximum receptiveness of stigma during anthesis. The flowers pollinated one day before anthesis exhibited the lowest mean percentage of pod set indicating that the stigma was premature or not receptive during that period. In general, the percentage of pod set was higher in the early morning hours (7.00 to 11.00 am) irrespective of the pollination done on different days. Stigmatic receptivity was found to be 50 per cent one day before anthesis and was maximum on one day after anthesis (83.33 per cent), although it continued to be receptive even upto 3 days after anthesis. In general, the stigma remains receptive for three days *viz*., one day prior to anthesis, on the day of anthesis, one day after anthesis. These receptive periods coincided with pre-anthesis, anthesis and post pollination stage of flower development. The loss of stigma receptivity can be identified from the change in stigma colour from green to red [1]

Pollen viability

The pollen germination percentage and mean length of pollen tube was higher on the day of anther dehiscence and a gradual reduction was observed thereafter as the age of the pollen grains advanced. This is normally expected since aged pollen grains might have lesser moisture content, leading to the deterioration of viability. In 1993, Mamtha *et al*. reported that 98.20 per cent of pollen germination was observed when treated with in 10 per cent sucrose solution. The mean percentage of fertile pollen in *G. superba* was maximum on the day of anther dehiscence and declined gradually as the age of pollen increased [1].

Pollination

Gloriosa superba is characterized by very low seed set in nature. The species is both self- and cross pollinated, seed set is dependent upon both pollinator activity and the time of pollination. Although there are no self or cross-incompatibility barriers, the hercogamous nature and attractively coloured flowers favours cross pollination. Only large insects like bumble bees and birds like *Nectarinia zeylanica* and *Nectarinia asiatica* with long beaks have been reported to be visiting these flowers. This limits the possibility of good cross-pollination, although wind is another factor which would be aiding in its pollination. To overcome this problem, the species has developed the mechanism of sequential opening of its flowers. An average of six flowers develops fully on a branch and they open in a sequential manner. The first flower opens towards the base of the branch with the subsequent flowers opening away from the first flower. No two flowers on a branch were observed to be at the same stage of development at any given time. The next flower opens only after the earlier flower has undergone pollination which is characterized by stigma losing receptivity and the perianth colour gradually changing to scarlet crimson.

In 1993, Mamatha *et al*. reported that fruit set was 90 per cent under artificial cross pollination, 100 per cent under artificial self pollination and only 40 per cent in glory lily under open pollination which indicates the need for artificial pollination. In 1994, Rajagopalan and Khader insisted that hand cross pollination gave 100.0 per cent pod set followed by natural cross pollination (78.8%) and open pollination (67.5%). Self pollination and controlled self pollination gave 25.2 per cent and 40.5 per cent pod set respectively. The fruit set in glory lily by hand out-crossing and selfing one day after anthesis was found to be 90 per cent and 100 per cent respectively [25].

In 2008 Nagajothi stated that hand pollination recorded the highest pod set per cent of about 70.93 per cent followed by air blowing pollination using power sprayer (65.52 per cent). Maximum pod set was observed in artificial cross pollination within the species followed by self-pollination. Minimum pod set was noticed in natural self or cross pollination. This is due to typical flower shape during the flower development. The peculiar structure of the large flowers with six perianth lobes bend backwards, six radiating anthers and the style bend almost 90^{o} at the point of attachment to the ovary, does not make them suitable for pollination by small insects [1].

Breeding Systems

Traditional or conventional breeding has not been attempted so far as there is only one ecotype under cultivation and genetic wealth is limited. Introduction of new variability is the only option for the breeders at present to create new variability for selection of high yielding cultivars. The growing demand for the seeds of *G. superba* in the international market and the wider popularity it gained among the farmers necessitates attempts to induce new variability with high yield, high colchicine content, dwarf stature and leaf blight resistant of the plant as well.

Selection and evaluation

In 2010, Chitra and Rajamani evaluated eighteen genotypes of Glory lily under tropical humid condition of Tamil Nadu. The genotype GS 15 exhibited superior performance for most of the morphological and yield characters, followed by GS 06. Seed yield per plant exhibited highly positive significant correlation both at phenotypic and genotypic levels for all the traits.

Hybridization

In *Gloriosa superba*, the genetic variability is low owing to the continued vegetative propagation through tubers. Wide hybridization enables the interspecific gene transfer, which may lead to the additional source of variation for desirable characters. In 2013, attempts were made by Anandhi *et al* to investigate the possibilities for developing variability in this species with varying flower colour, shelf life, high seed yield and improved colchicine content through interspecific hybridization using *Gloriosa superba* with *G. rothschildiana*. Varying percentage of pod set was observed with pods of 2.00 cm length within 25 days of pollination and thereafter shrinked and died irrespective of the cross combination under study. None of the pod reached the harvestable stage. Post fertilization barrier was observed in both

direct and reciprocal crosses. This may be due to embryo abortion and degeneration during embryogenesis.

Mutation breeding

In Gloriosa, only local ecotypes are under cultivation and genetic wealth is very limited. Therefore, generation of variability through mutagenic treatments is of paramount importance for improvement of Glory lily. In 1991, Chandra and Tarar worked on development of mutants using Co-60 gamma rays, EMS and DES on *G. superba* and obtained various morphological changes in height, structure of the plant, flower and capsules under gamma treatments. Multi armed tubers and furcated stem mutants under EMS and flower size mutants under DES treatment was obtained. In 2001, Rajadurai and Vadivel concluded that colchicine content of leaves was higher on treatment with gamma rays @ 1.00 kR and also the yield attributes was greater in the treatment DES @ 0.75 per cent. In 2013, Anandhi et al obtained high colchicine (0.707%) containing mutants in VM2 generation with 2% EMS followed by 0.702 per cent in 1.00 % DES mutagenic treatments.

Cultivation

Red, loamy soils with good drainage and a pH range of 6.5-7.5 are suitable for cultivation of this species. The ideal temperature for cultivation of this crop is between 25 and 32ºC during day and 15-20ºC during night. Regions with high humidity (>70 per cent) is vulnerable to *Curvularia* blight (leaf blight) causing severe mortality of the vines. *Gloriosa superba* is propagated by tubers, seeds and by micro-propagation. Tubers each weighing 40-60 g are selected for planting as they are vigorous and ensures maximum field stand. In 2012, Anandhi and Rajamani reported that treatment with ethrel @ 500 ppm recorded maximum sprouting percentage (100 %), earlier sprouting of tubers (6.33 days), maximum plant height (99.32 cm) and maximum number of leaves per plant (34.04) and plant girth (1.81 cm). Enhanced seed germination (97%) by incubation at 20–25°C for a period of 31 days [14]. Seedlings grow rapidly and produce tubers by their second year; flowering starts in the third or fourth year. In 2000, Munavarjan reported that explants (tuber nodes and shoot tip) of glory lily resulted in better micro shooting with MS medium supplemented with BAP 3.0 mgl^{-1}. In 2014, Gopinath et al. indicated that 93.80% of microshoots were regenerated from the callus on MS medium with combination of GA (8.0 mgl^{-1}), IAA (4.0 mgl^{-1}) and BAP (2.0 mgl^{-1}). The rooted shoots were transferred into small polythene bags which contain a sterilized cow dung powder, sand and red soil in the ratio of 1:2:3 and kept in a mist house. After acclimatization in the mist house, the regenerated plantlets were hardened in the greenhouse and transferred into soil, which showed 80% survival rate.

Field is prepared by formation of ridges measuring 45 cm width, 45 cm height and of convenient length depending upon the local soil types for planting of tubers. For conventional irrigation system, farmers adopt furrow planting. Planting of tubers is done during July-August. The tuber rate varies from place to place and in practice, farmers use 1-2 ton of healthy tubers to plant one hectare of land. The tubers are planted at a spacing of 45-60 cm. As a prophylactic measure against soil borne pathogens, application of *Trichoderma viride and Pseudomonas fluorescens* (each at 5 kg/ha.) is recommended.

Support

Being a climber, glory lily requires support in the form of trellies or standards. The sprouted tubers are trained over the support which is made of galvanized iron wire at 1.5 m height. Farmers also support the vines with live fences like *Balsmodendron* (Kiluvai) and with locally available dead wood of *Dodonea viscosa*, cashew, neem etc.

Manures and fertilizers

Gloriosa superba is an exhaustive crop and demands more nutrients from the soil for growth and development of plants, flowering, seed set, pod maturity besides, to meet the nutritional requirement for tuber growth and multiplication of daughter tubers for the next generation. The tubers have shallow root system comprising mainly fibrous root which can absorb water and nutrients available in the localized zone. These small fibrous roots can absorb the nutrients in gradual doses for which nutrients have to be applied in several split doses. The fertilizer dose applied should suffice the nutrient requirement during various critical stages of crop growth. The maximum seed yield was obtained with 150:50:100 kg of NPK ha^{-1}, along with vermicompost @ 5t /ha (as basal) combined with basal dose of $ZnSO_4$ @ 25kg/ha, $FeSO_4$ @ 50 kg/ha, Borax @ 10 kg/ha, Sodium molybdate @ 0.5 kg/ha at the time of planting along with foliar application of $FeSO_4$ (1%), $ZnSO_4$, (0.5%) Boric acid (0.2%) and giberellic acid as foliar spray twice @ 200 mg/kg at critical stages of crop growth.

Interculture

The crop is capable of withstanding drought. In Tamil Nadu, majority of glory lily farmers adopt drip irrigation. The first three months are critical and irrigation must be ensured two or three times in a week. Later during peak flowering (between October and December), irrigation can be given twice in a week. As flowering, pollination, pod set and pod maturity occurs concurrently and continuously, irrigation must be ensured uniformly covering these stages of growth. In the early stage of crop growth, frequent weeding is required to control the weeds which will otherwise compete with plants for moisture and nutrients and will restrict the growth of the plant. Chemical weed control is possible only when there is wide spacing between the rows and the plants themselves.

Harvest and yield

From planting of tubers to final seed harvest, the crop requires 160-180 days of duration. The right stage of harvest is when the capsule starts turning light-green from dark-green and the skin of the fruit shows a shrunken appearance and becomes light in weight. At this stage, when pressed, the pod gives a crinkling sound. Mature pods are manually harvested. On an average, a seed yield of 300-500 kg/hectare can be achieved in the first year. During second and third year, the seed yield ranges from 250-300 kg/hectare. The tuber yield after third year will be 2.5 ton/hectare.

Crop Protection

Insect Pests

Lily caterpillar (Polytela gloriosae)

It is a serious and regularly occurring pest on glory lily any time during the cropping season (August to February) from seedling stage to maturity.

Semilooper (Plusia signata)

Eggs are laid singly on underside of leaves. The green coloured larvae present under the leaves and cause extensive defoliation. But the larvae do not attack the growing tips. These semiloopers are considered as important pests next to lily caterpillars. For the management of defoliators of *G. superba*, foliar application of neem seed kernel extract 5% or neem oil 3% is recommended to be effective. As a last resort, when the pest population crosses the economic threshold level of 10 per cent defoliation, any one of the following insecticides may be sprayed; quinalphos 25 EC @ 750 ml/ha, chlorpyriphos 20 EC 1,250 ml/ ha, azadirachtin 10,000 ppm @ 500 ml/ha, *Bacillus thuringiensis* 1000 ml/ha [27].

Thrips (Thrips tabaci)

In Gloriosa, these thrips transmit necrosis - a viral disease. Virus infected plants develop a bronze or purple discoloration. Leaves curl downwards and are distorted. Numerous small, dark spots develop on leaves and leaf stalks. Affected leaves may wilt and die. For the management, foliar application of fipronil (750 ml/ha) or spinosad (200 ml/ha) twice at 15 days interval is recommended [28].

Diseases

1. Root rot (Macrophomina phaseolina)

Root rot is a destructive disease in *Gloriosa superba* causing yield loss to the tune of 20 to 30%. Sudden and complete wilting of plants appears in patches. Yellowing of leaves, discolouration and decaying of roots are the prominent symptoms of root rot disease. Such affected plants are finally killed due to severe root rot.

2. Leaf blight (Alternaria alternata)

It is a serious disease in *G. superba* and observed during October to December. Early symptoms appear as small, circular to oval, light brownish spots, 2-6 per leaf, scattered at the tip, margin and midrib of the leaves. Each spot has a central necrotic lesion with concentric rings. At an advanced stage, the spots become dark brown to blackish in colour, gradually coalesce and become irregular in shape, then the affected leaf blights completely. The growth of *A. alternata* was maximum in pH range of 6-6.5 and temperature range of 25-30°C.

3. Tuber rot (Rhizoctonia bataticola)

Tuber rot is a serious disease in *Gloriosa superba* causing yield loss to the tune of 20%. The pathogen affects the underground tuber causing death of the plant. In the initial stages, infected tubers start becoming soft and the foliage exhibits yellow appearance. In advanced stages, the whole tuber gets infested giving an appearance of discoloured mass and the plant dies off. The disease can be controlled by

The diseases can be controlled by removal of infected plants, providing adequate drainage and soil application of *Pseudomonas fluorescens* @ 2.5 kg/ha along with neem cake 250 kg/ha, dipping tubers in *P. fluorescens* (2 g/litre) or carbendazim (0.1%) for 20 minutes before planting followed by spraying with tebuconazole (0.1%) on 30 and 60 days after planting.

Post harvest technology

After picking of pods, they are stored in jute bags and kept in the shade for 2 to 3 days to facilitate the capsules to open up, displaying deep orange yellow coloured seeds. The whole husk with seeds intact is dried in shade for 3-4 days by spreading them uniformly over any clean, dry floor or any platform specially erected for the purpose. After this, seeds and pericarp are separated manually by beating with wooden stick to remove seeds and pericarp. The seeds are then spread thinly over the drying yard under open sun and dried for 2-3 days until it dries uniformly. The Department of Agriculture Processing, TNAU has developed an improved glory lily seed thresher which can extract the seeds from pods at the rate of 250 kg of fresh seeds in one hour. The equipment is operated by 5 HP motor which cost around Rs.90,000 per unit and can be moved easily from one farm to other [30]

In 2008, Balakumbahan and Rajamani studied the various methods of drying of *Gloriosa* seeds and concluded that the highest colchicine and colchicoside content (0.419 and 0.291 per cent respectively) was obtained in the samples dried in mechanical drier at 40°C followed by shade drying of seeds.

PHYTOCHEMISTRY

The medicinal importance of *G. superba* is due to the presence of alkaloids in all parts of the plant, mainly colchicine, an amino alkaloid derived from the amino acids phenylalanine and tyrosine. Colchicine is an alkaloid drug, chemically known as N-[(7*S*)-1, 2, 3,10-tetramethoxy-9- oxo- 5,6,7,9 – tetrahydrobenzo [*a*] heptalen-7-yl] acetamide, is widely used for the treatment of gout disease. Gout is caused by deposition of microcrystals of uric acid in joints and may be due to defective regulatory mechanism for endogenous purine synthesis. Distressing side effect has also been recorded sporadically but colchicine remains the drug for acute gout. Colchicine also acts as anti-mitotic and anti-gout agent. It blocks or suppresses cell division by inhibiting mitosis. It inhibits the development of spindles as the nuclei are dividing (spindles are formed by the polymerization of tubuline) from a pool of subunit during a detached phase of cell-cycle and then depolymerized during other phase. It is also used to induce polyploidy initiation, occasionally other mutations also occur like chlorophyll mutations, but frequency is low. It can solve an important problem of fuchsia breeding. Colchicine is mostly used in its freshly prepared aqueous form. The range of concentration of colchicine applied varies from 0.006- 3%, concentration of about 0.05% is the most commonly used [17]. In 2004, Sivakumar and Krishnamurthy reported on the biosynthesis of colchicine, the *in vitro* supply of exogenous precursor using B5 medium from *G. superba* calluses. The maximum amount of colchicine i.e. 9.0 mg was detected in the medium fed

with 30 µM tyrosine. In 2008 Khan et al. studied on the antimicrobial potential of *G. superba* extracts in which excellent antifungal activity was confirmed against *Candida albicans*, *C. glabrata*, *Trichophyton longifusus*, *Microsporum canis* and *Staphylococcus aureus.* In 2011, Kavina et al reported that gibberellic acid and *Psedomonas aerugenosa* was found useful to increase the colchicine content in seeds and tubers. The isolation of colchicine and colchicoside involves extraction of the plant material with a suitable solvent followed by fractionation of the extract, chromatography and crystallization. All the materials required for production of colchicine and colchicoside are indigenously available. Thiocolchicoside (TCC), a semi-synthetic derivative of naturally occurring colchicoside from the seeds of *Gloriosa superba* and *Colchicum autumnale*. The average yield of colchicine from the seeds of *G. superba* is around 0.6% while that of colchicoside is up to 0.2 percent. More than 95% purity levels were achieved.

CONCLUSION

Although *Gloriosa superba* is a commercially grown medicinal plant, tubers are still collected from the wild leading to habitat loss. The species is vulnerable under wild and IUCN has affirmed the need for conserving the species. On the other hand, to reduce the pressure on wild habitat, protocol available for rapid propagation of this species (through seed and tissue culture) should be effectively utilized to generate adequate planting material for the benefit of farmers. Glory lily cultivation has succeeded for nearly 25 years and approximately 15,000 ton of seeds have so far been produced and traded. Knowledge on supply and value chain, market information and future prospects need to be studied to benefit the farmers and the phyto-pharmaceutical industry.

REFERENCES

1. Anandhi S, Rajamani K . 2012, Studies on seed germination and growth in *Gloriosa superba* L., *Global J Res. Med. Plants & Indigen. Med.*, Volume 1(10): 524–528
2. Anandhi,S., K. Rajamani, M. Jawaharlal, M. Maheshwaran and R. Gnanam. 2013. Interspecific hybridization in glory lily. American International Journal of Research in Formal, Applied & Natural Sciences. AIJRFANS 13-135
3. Animesh Biswas*, SN Muntaha and MM Rahman, 2014. Comparative karyotype analysis in two life-forms of *Gloriosa superba* L. *Journal of Pharmaceutical Biology, 4(2), 77-80.* 77
4. Balakumbahan, R. and Rajamani, K. 2008. Studies on standardization of pre and post harvest treatments in *Gloriosa superba* L. Ph.D (Hort). Thesis, Tamil Nadu Agricultural University, Coimbatore.
5. Chandra, N. and Tarar, J.L. 1991. Morphological characters affected by mutagens in *Gloriosa superba* L. In: Golden Jubilee symposium Genetic Res. Edn. Curr. Trends and Next Fifty Years (Abstr.); held under the auspices of Indian Soc. Gent. Pl. Br. IARI, New Delhi, from Feb. 12-15, Vol,III: 770.
6. Chitra R, Rajamani K. 2010. Assessment of different glory lily (*Gloriosa superba* L.) accessions for biochemical tests. *Res J Med Plant*; 4:21–5.
7. Dhushara, 2004. http://www.dhushara.com/book/med/med.htm
8. Duke, J.A., 1992. Handbook of phytochemical constituents GRAS herbs and other economic plants. CRC Press, BocaRaton, Florida, United States. 654 pp.
9. Farooqi, A.A., Kumaraswamy, B.K., Bojappa, K.N.,Pusalkar, V.R. and Gupta, R., 1993. Plantations of the clinically important *Gloriosa superba*. Indian Horticulture 37(4): 26–29.
10. Ghani, A. 1998. Medicinal Plants of Bangladesh (Chemical Constituents and Uses). Asiatic Society of Bangladesh, Dhaka. 25. Gooneratne, B.W.M. 1966. Massive
11. Gopinath K., Karthika V., Gowri S. and Arumugam A. 2014. *In vitro* morphogenetic regeneration from root explant of *Gloriosa superba* L. for Enhanced Crop Production. 27 the Scitech Journal Vol. 01 Issue 08 .
12. Kavina .J, R.Gopi and R.Panneerselvam, 2011. Quantification of colchicine in seed and tuber samples of *Gloriosa superba* by High Performance Liquid Chromatography method. *Journal of Applied Pharmaceutical Science* 01 (07); 2011: 116-119
13. Khan, H., M.A. Khan, and T. Mahmood. 2008. Antimicrobial activities of *Gloriosa superba Linn* extracts. *Journal of Enzyme Inhibition and Medicinal Chemistry* 6: 855-859.
14. Le Roux, L.G. and Robbertse, P.J. 1994. Tuber ontogeny and vegetative reproduction of *Gloriosa superba* L. South African Journal of Botany 60: 321 -324.
15. Mamtha, H. 1989. Studies on the problem of fruit set and its improvement in *Gloriosa superba* L. M.Sc. (Hort) Thesis, University of Agricultural Sciences, Bangalore.
16. Mamtha H, Farooqi AA, Joshi SS, Prasad TG. 1993. Pollen studies in *Gloriosa superba* Linn. *Acta Hortic*; 331-371.
17. Milne, S.T. and P.D. Meek. 1998. Fatal colchicine overdose: report of a case and review of the literature. *American Journal of Emerging Medicine* 16: 3-8.
18. Munavarjan, S. 2000. Micropropagation in *Gloriosa superba* L. M.Sc. (Hort) Thesis, Tamil Nadu Agricultural University, Coimbatore.
19. Nagajothi, V. 2008. Studies on induction of pollination and improvement of fruit set and yield through growth promoting substances in glory lily (*Gloriosa superba* L.). M.Sc. (Hort) Thesis, Tamil Nadu Agricultural University, Coimbatore.
20. Neuwinger, H.D. 1994. *African Ethnobotany Poisons and Drugs Chemistry, Pharmacology, Toxicology.* Weinheim: Chapman & Hall.

21. Rajadurai, K.R. and Vadivel, E. 2001 . Enhancing the bioproductivity of *Gloriosa superba* L. through mutatic genetic manipulation. Ph.D. (Hort) Thesis, Tamil Nadu Agricultural University, Coimbatore.
22. Rajagopalan, A. and Md. Abdul Khader, J.B.M. 1994. Investigation on certain aspects of growth, development, crop production and quality in glory lily (*Gloriosa superba* L.). Ph.D. (Hort) Thesis, Tamil Nadu Agricultural University, Coimbatore.
23. Rastogi, R.P. and Mehrotra, B.N. 1993. Compendium of Indian Medicinal Plants, Vol I-V. CDRI, Lucknow and Publication and Information Directorate, New Delhi, India.
24. Saravanan, S. and Buvaneswaran, C. 2003. *Gloriosa superba* cultivation in Tamil Nadu. A socio-economic analysis. Advances in Plant Sciences 16(1): 23 -28.
25. Sivakumar, G. and K.V. Krishnamurthy. 2004. *In vitro* organo genetic responses of *Gloriosa superba*. *Russian Journal of Plant Physiology* 51: 790-798.
26. Sudhendra and H. Rudre Gowda. 1997. Final Report -The ADHOC Scheme Collection and evaluation in *Gloriosa superba* L. and germplasm for identifying superior lines for domestication. UAS, GKVK, Bangalore.
27. Suganthy, M., P. Sakthivel, L. Nalina and R.M. Vijayakumar. 2013. Bio-efficacy of botanicals and bio-pesticides in the management of defoliator complex of *Gloriosa superba*. In: Proceedings of National conference on "Integration of Medicinal and Aromatic Plans for Rural Development and Prosperity" held at Medicinal and Aromatic Plants Association of India, January 22 & 23, Anand, Gujarat, India, pp.28.
28. Suganthy, M., L. Nalina, P. Sakthivel and R.M. Vijayakumar. 2014. Arthropod biodiversity in *Gloriosa superba* Linn. The State flower of Tamil Nadu. In: Perspectives on Biodiversity of India. Volume I. (Biju Kumar, A., A. Rajendran, P.G. Peethambaran, C.K., Eds), Centre for Innovation in Science and Social Action.
29. Tarar, J.L. and Vishwakarma, M. 1995. Chromosome of diploid and tetraploid *Gloriosa superba* Linn. In: Padhye, M.D., Mukherjee, P.K. and Khalatkar, A.S. (Editors). Botany towards 2000 A.D. (Prof. V.R. Dnyansagar.
30. TNAU Agriculture portal. Horticulture. Available from: http://agritech.tnau.ac.in/horticulture/horti_spice%20crops_fenugreek.html