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# GLORY LILY (*Gloriosa superba* L.) : AN IMPORTANT MEDICINAL CROP– A REVIEW

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**ABSTRACT :** *Gloriosa superba* L. is an important medicinal plant of Asia and Africa, used in treatment of several diseases. It is cultivated for its seeds for extraction of colchicine and colchicoside forming the principal source of drugs. In India, Tamil Nadu holds monopoly in production of glory lily. There is a need to standardize the production technology which may help to improve the yield, quality and net returns per unit area. The present review is focused on production practices of *Gloriosa superba* L.

***Keywords:*** *Gloriosa superba, phytochemicals, colchicine.*

Glory lily (*Gloriosa superba* L.) is an important medicinal crop which belongs to family Liliaceae. It is commonly known with different vernacular names like *Agnishikha, Agnimukhi* and *Garbhaghatini* in Sanskrit; *Bachnag, Languli* and *Karihari* in Hindi; Supper lily, Tiger claw, Flame lily in English; *Agnishekhe, Akka thangi balli* and *Karadikannina gadde* in Kannada and *Kallavi* and *Kariannag* in Marathi (Anon., 6). Glory lily is native to Tropical Asia and Africa. Its natural distribution spreads mainly in tropical Asia, *viz.,* India, Sri Lanka, Malaysia and Myanmar. In India, it is usually found in Himalayan foot-hills, central India, Tamil Nadu, Andhra Pradesh, Karnataka and West Bengal. Tamil Nadu holds a monopoly in production of glory lily with an annual production of about 600 tonnes of seeds in an area of about 6000 acres. The phytochemicals present in glory lily have analgesic, anti-inflammatory, antithrombotic, enzyme inhibitory, anti-venon and chemotherapeutic potential. Different parts of this plant are used in Indian system of medicines for different purposes. Tubers are used as a tonic, stomachic, anthelmintic when taken in doses of 5-10 grains (Modi, 25), anti-periodic, abortificient and against snake bites and scorpion stings. The leaves when applied as paste to forehead and neck are reported to cure asthma in children. The leaf juice was being used effectively against head lice (Kirtikar and Basu, 22). Glory lily is mainly cultivated for its seeds for extraction of colchicine and colchicoside forming the principal source of drugs used for treating gout, rheumatism and for inducing polyploidy in plants (Farooqi, 19). Methanolic extract of defatted seeds have shown *in-vitro* nematicidal property against Meloidogyne incognita (Anon., 7). The lethal dose of colchicine is 6 mg per kg. The colchicine content in tubers is ranged between 0.15- 0.30 per cent whereas that in seeds is 0.7- 0.9 per cent (Farooqi, 19).

There is very little variability available for seed yield and colchicine content in glory lily. Hence, there is a need to standardize the production practices to grow the crop economically and produce export quality material. Standardization of production technology may help to improve the yield, quality and net returns per unit area. This may help to promote the cultivation of this crop on commercial scale. In this regard the studies on different aspects of glory lily are reviewed and presented under different headings.

## Genotypic Evaluation Studies

Eighteen genotypes of *Gloriosa superba* L. from different places of Tamil Nadu and Andhra Pradesh were subjected to diversity analysis. Significant genotypic differences were observed and genotypes were classified accordingly into seven clusters. The study showed that hybridization among these genotypes can generate desirable transgressive segregants (Chitra and Rajamani, 14). The another of variability for qualitative and quantitative traits of *G. superba* collected from different regions of Tamil Nadu and Andhra Pradesh, clearly indicated that less variation existed between genotypes with respect to morphological traits which are useful tools for preliminary evaluation because; they offer a fast and reliable approach for assessing extent of diversity.

Chitra and Rajamani (15) studied eighteen glory lily genotypes to estimate character association and generate a path analysis for 13 morpho-economic traits. Plant height, number of leaves per plant, number of branches per plant, days to 50% flowering, number of flowers per plant, number of pods per plant, number

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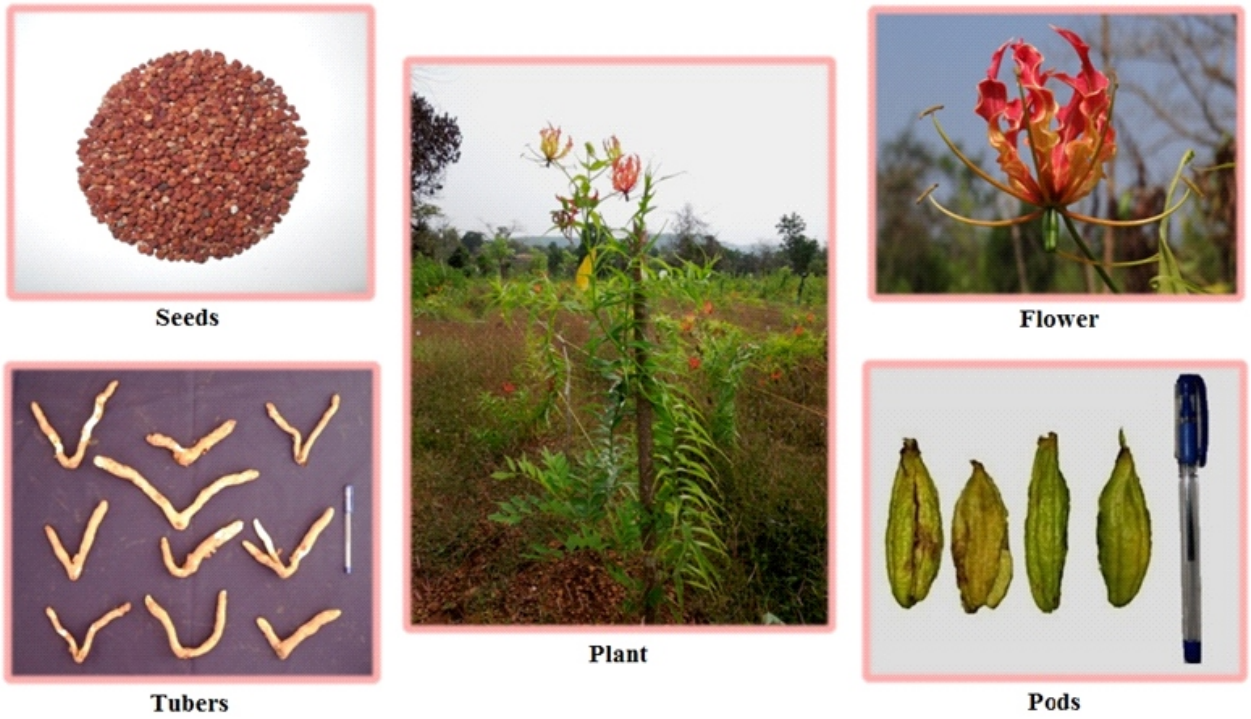


Fig. 1: Plant and plant parts of glory lily

of seeds per plant, fresh seed weight per plant, fresh seed yield per plant and fresh seed recovery were found to have positive association with dry seed yield per plant. Fresh seed yield per plant had highest positive effect on seed yield followed by number of pods per plant and fresh seed weight per pod. These associated yield components suggested that it may be good selection criteria to improve seed yield of glory lily (Chitra *et al.,* 17).

Studies on the performance of some promising genotypes of Glory lily against leaf blight disease (Chitra *et al.,* 16) revealed that all genotypes expressed significant variations for per cent disease index (PDI). The genotypes GS 07 and GS 05 exhibited the lowest index (21.73%) and highest index (64.48%), respectively. The PDI exhibited highly positive significant correlation both at phenotypic and genotypic levels for polyphenol oxidase. But it had negative significant association with peroxidase, total phenol content and catalase activity. The genotype GS 07 exhibited the lowest PDI value and this genotype considered as tolerant to leaf blight.

## *In-vitro studies*

In a study, Bharathi and Philomina (11) investigated the effect of nutritional factors and the precursors on colchicine production in callus cultures of *Gloriosa superba* in order to optimize the colchicine production *in vitro.* Colchicine content in the callus, grown in the medium with sucrose as carbon source and 40 mM ammonium nitrate as nitrate source showed the greatest promise with highest biomass and colchicine content. In addition to this, sulphate ions (40 mM) markedly increased the formation of colchicine. In contrast, highest concentration of phosphate (2.5 μM) and calcium (10 μM) were found to be inhibitory for colchicines formation. Precursors (40 μM tyrosine) also influenced the colchicine content (9.79 mM dry weight) with the above mentioned nutritional effect.

In a histological study on indirect organogenesis from internodal cultures of *Gloriosa superba* L., Madhavan and Josef (24) concluded that the callus initiated from the sub epidermal cells. The organogenic and non organogenic calli were the result of hormonal variation in the medium. In non organogenic callus, cells redifferentiated into xylem elements forming clusters of nest like structures. In organogenic callus, cells redifferentiated into nodules of meristemoids which further differentiated into shoot apical meristem.

The *in vitro* tuberization of glory lily (*Gloriosa superba* L.) was studied by Selvarasu and Kandhasamy (30) using non-dormant tubers on Murashige and Skoog medium supplemented with various concentrations growth regulators. MS medium supplemented with 4.0 mg $L^{-1}$ BAP and 1.0 mg $L^{-1}$ NAA recorded the highest response for primary tuber (100%) and secondary tuber (100%) formation. This

also recorded the maximum number of tubers (1.77) from single explants.

Excised root cultures of *Gloriosa superba* reached 7.5 g dry weight $l^{-1}$ and accumulated 240 ± 40 µg colchicine $g^{-1}$ cell dry weight after 4 weeks growth. While all precursors (*except trans* cinnamic acid) enhanced colchicine content of root cultures without adversely affecting root growth, treatment with *p*-coumaric acid + tyramine (each at 20 mg $l^{-1}$) increased colchicine content to 1.9 mg $g^{-1}$ cell dry weight (Ghosh *et al.,* 20).

Ghosh *et al.* (21) studied the effect of Aluminium chloride on colchicine production in root cultures of *Gloriosa superba* L. Root cultures were treated with 5 mM methyl jasmonate and 125 µM $AlCl_3$ which enhanced the intracellular colchicine content of the roots by 50-fold and 63-fold, respectively. Ten milli molar of $CaCl_2$ and 1 mM $CaCl_2$ enhanced biomass significantly (7 to 8.6-fold, respectively) while maximum release of colchicine into the medium was obtained with 10 mM $CaCl_2$. Casein hydrolysate, yeast extract and silver nitrate had no significant effect on growth and colchicine accumulation in root cultures.

MS medium supplemented with 2,4-D 4.52 µM and BAP 13.30 µM promoted the formation of the maximum number of shoots compared to IAA, IBA and with Gamborg B5 medium supplemented with kinetin, IBA and BAP were found to be superior. (Ade and Rai, 2).

## Propagation

Venudevan *et al.* (33) conducted an experiment to optimize the seed dormancy breaking treatment in Glory lily (*Gloriosa superba* L.). The study revealed that soaking the seeds in hot water (boiled to 100°C and removed from the flame) for 40 minutes had effectively improved the seed germination (62%), seedling length (27.1 cm), seedling dry matter (181.0 mg) and vigour index (1680) accompanied with less hard seeds (15%) and minimum abnormal seedlings (14%), compared to acid scarification with concentrated $H_2SO_4$ for 2 minutes that improved the germination (52%) over non-scarified seeds (22%), but led to the development of abnormal seedlings (14%) and dead seeds (12%) at an increased level. Similarly, studies on imposing seed germination in glory lily revealed that seeds soaked in hot water for one hour was recorded to be the best treatment with maximum germination of 32.75 % and vigour index (565.92). So, the seed treatment can be recommended as a nursery practice. Earlier germination (48.35 days) was observed for the seeds soaked in hot water, when compared to other chemical treatments. The maximum number of leaves and root length was recorded for the seeds soaked in $GA_3$ at a concentration of 250 ppm (Anandhi and Rajamani, 5).

## Nutrition Studies

Application of enriched farm yard manure at 750 kg per ha recorded the highest yield attributes like number of capsules per plant (20.32), number of seeds per capsule (44.88), test weight (2.29 g), seed yield (686.9 kg per ha) and tuber yield (2149 kg per ha) in glory lily (Deivasigamani and Thanunathan, 18).

A fertilizer dose of 120 kg N, 50 kg $P_2O_5$ and 75 kg $K_2O$ per ha is required for a good crop. Of the nutrients, the whole $P_2O_5$ and $K_2O$ and one third of N is applied as a basal dose and the remaining two third of N should be given in the first six to eight weeks after planting (Abraham, 1).

In an experiment, Mohanaramya *et al.* (26) reported that application of 125 per cent of 150: 100: 300 Kg NPK per hectare by fertigation using water soluble fertilizers registered the highest values for yield parameters like number of flowers per plant (72.37), number of pods per plant (62.91), number of seeds per pod (78.02), fresh seed yield per plant (356.31g), dry seed yield per plant (58.64 g), estimated yield of dry seed yield per hectare (1055.52 kg). The same treatment also influenced the tuber yield and nutrient content in tubers significantly, compared to straight fertilizer treatments, the treatments which received water soluble fertilizers recorded good responses. Whereas, Vasanthi *et al.* (32) reported that application of 100:50:100 Kg of NPK/ha. for Palathurai and Palaviduthi soil series and 150:50:100 Kg of NPK/ha for Irugur soil series along with $ZnSO_4$ @25 Kg/ha, $FeSO_4$ @ 25 Kg/ha, Borax @10 Kg/ha, and sodium molybdate @ 0.5 Kg/ha at the time of planting along with foliar application of $ZnSO_4$ (0.5%)., $FeSO_4$ (1%), Borax (0.2%) and gibberellic acid spray twice @200mg/kg at critical stages of crop growth recorded the higher seed yield and colchicines content.

In a hydroponic green house experiment on glory lily, Lohacharoen and Ruamrungsri (23) found that nitrogen at 210 mg per litre concentration was optimum for glory lily cultivation which resulted in significantly better plant height, tuber weight and higher number of flowers and pods.

## Growth promoters, bio agents and bio-formulations

In a study on foliar application of bio-control agents in *Gloriosa superba.* L., Balakumbahan and Rajamani (10) concluded that foliar application of humic acid 0.1% + panchagavya 4% + vermiwash 20% combined with foliar application of *Pseudomonas*

*fluorescens* + *Trichoderma viride* along with the recommended dose of fertilizers resulted healthy plant growth and better pod development ultimately the seed yield.

Nagajothi *et al.* (27) reported that, $GA_3$ 50 ppm recorded highest performance for most of the yield attributes in terms of fresh weight of the pod (11.53g), fresh weight of pods per plant (296.67 g), dry weight of pods per plant (89.54 g), number of seeds per pod (65.3), fresh weight of seeds per pod (8.07 g) dry weight of seeds per pod (2.30 g), fresh weight of seeds per plant (205.87 g) and dry weight of seeds per plant (57.67 g) respectively which was followed by the application of Brassinosteroid 1 ppm (11.39 g, 287.07 g, 88.84 g, 64.7, 7.98 g, 2.28 g, 203.37 g and 56.97 g, respectively).

Under *in vitro* conditions a commercial formulation of *Trichoderma viride* and *Pseudomonas fluorescens* inhibited the mycelial growth of *Macrophomina phaseolina* isolates. Mahua cake at 10% completely inhibited the mycelial growth of the *Macrophomina phaseolina* isolates. Under field conditions both the soil and foliar application of biocontrol agents is attributed to the healthy growth of *Gloriosa superba* crops by controlling the tuber rot disease and ultimately boosting the colchicine content (Alice and Sundravadana, 4).

## Pollination, seed development and maturation studies

An experiment was conducted on improved method of pollination and influence of growth promoting substances on the pod and seed yield in glory lily. Hand pollination exhibited the highest performance in terms of high pod set (70.93%), fresh weight of pods / plant (235.26 g), dry weight of pods/ plant (91.67 g), number of seeds / pod (67.7), fresh weight of seeds / pod (6.54 g), dry weight of seeds /pod (1.88 g), fresh weight of seeds / plant (190.26 g) and dry weight of seeds /plant (56.06 g), respectively followed by air blowing method of pollination (65.52 %, 220.22 g, 83.09 g, 57.1, 5.16 g, 1.81 g, 163.35 g and 50.04g respectively) with higher BCR (4.58) than the assisted hand pollination (Nagajothi *et al.,* 27.)

An experiment conducted to improve the fruit set and yield inferred that combined treatment of hand pollination and foliar application of 0.1% $H_3Bo_3$ + 0.5% $ZnSO_4$ at fortnightly intervals from 50% flowering exhibited high fresh weight of seeds/plant (232.66g), dry seed weight of seeds /plant (41.53g). The effect was equally good in pollination through air blowing combined with of 0.1% $H_3Bo_3$ + 0.5% $ZnSO_4$ which recorded 79.66% pod set, fresh seed weight of 230.15g/plant, dry seed weight of 41.47g/plant. High BCR (1.86) was obtained with air blowing method of pollination in combination with of 0.1% $H_3Bo_3$ + 0.5% $ZnSO_4$ as it incurred less cost in terms of cost for pollination (Nandhini *et al.,* 28).

Raina and Gupta (29) conducted a study on different pollination methods (natural, controlled selfing and crossing). No genetic self or cross incompatibility was observed. Although flower colour and shape favour cross-pollination, self-pollination has given better results. Controlled selfing between flowers on the same plant (idiogamy) has given significantly higher seed yield (9.20 g per plant and 681.73 kg per hectare), as compared to natural pollinated ones (4.31 g per plant and 319.26 kg per hectare). The controlled pollination can be attempted when the perianth lobes are crimson coloured at the top, and middle portion yellow with greenish base, when the stigma is most receptive for pollen germination.

In study on seed development and maturation, Venudevan *et al.* (34) concluded that the physiological maturity of glory lily was attained on 63 to 70 days after anthesis. It was associated with changes of colour of pods from dark green to light green with deep yellowish orange seeds, with higher germination, seedling length, dry matter production and vigour.

## Quality improvement

Investigations were carried out by Balakumbahan *et al.* (9) to study the effect of different drying methods on the respective alkaloids contents. The results revealed that, sun drying of *Gloriosa superba* seeds over 700 gauge black polythene sheet under open drying conditions reduced the drying time whereas, in mechanical drying method increase in drying air temperature significantly reduced the drying time. Regarding the alkaloids content, shade drying under ambient room condition and mechanical drying of seeds at 40°C recorded higher alkaloids recovery.

In a hydroponic greenhouse experiment on glory lily, Lohacharoen and Ruamrungsri (23) reported that nitrogen at 420 mg per litre concentration has given highest colchicine content (90.469 mg/plant) at flowering stage.

Application of 125 per cent of 150: 100: 300 kg NPK per hectare by fertigation using water soluble fertilizers registered the highest values for the quality parameters like colchicines (0.389%) and colchicoside (0.264%) in glory lily. Mohanaramya *et al.* (26) However, Vasanthi *et al.* (32) suggested application of 100:50:100 kg of NPK per ha for Palathurai and Palaviduthi soil series and 150:50:100 kg of NPK per ha for Irugur soil series to realize the higher colchicine content.

## Economics

The economics of production of glory lily was studied by Sundar and Kambai raju (31) in Tamil Nadu with a sample size of 100 farmers. The cost of establishment was ₹ 63,423.0 and the average cost of maintenance was ₹ 17,956.60 per ha per year. The expenditure on manures and fertilizers (₹ 7034.20) was the single largest items and total cost of cultivation per ha was ₹ 38,138.35 and gross returns and net returns per ha were ₹ 1,46,556.50 and ₹ 1,08,418, respectively.

In an economic analysis of cultivation and marketing of glory lily in Tamil Nadu, the worked out cost of cultivation per ha per year was ₹ 2.38 lakhs. The gross returns and net returns per ha per year were ₹ 4 lakhs and ₹ 1.612 lakhs, respectively. The study revealed that cost of cultivation in first year was very high (₹ 6.68 lakhs) and decreased to ₹ 0.72 lakh by fifth year and gross returns in first year were high (₹ 6.69 lakhs) and in the previous year it was very low (₹ 0.72 lakh) but net returns in first year were negative (₹ -0.69 lakh) and high (₹ 3.90 lakhs) on second year (Aijan *et al.,* 3).

## Others

*Langali* (*Gloriosa superba* L.), obtained from wild habitat and by experimental cultivation under three groups, viz., control, cultivated as per the modern agricultural guidelines, and as per the norms of *Vriksha-ayurveda* was compared and analyzed. Methods of *Vriksha-ayurveda* give good result in the case of Langali in terms of yield. Failure of control groups both in seed and tuber batches denotes that this plant needs some treatment for vegetative propagation under artificial conditions. Ayurveda group may be considered as a better one in the assessment of reproduction capacity in terms of yield of seeds. (Asha *et al.,* 8)

Chetoshi *et al.* (12) studied development and dormancy of tuber of *Gloriosa superba* L. grown in different season (crop production & cropping type). The fastest growth of tubers was observed in summer culture, and the slowest in winter culture. Secondary tuber formation occurred in spring and summer culture, especially for 'Tropical Red' and 'Rose Queen'. In winter culture, the period required to sprout new tubers, i.e. index of dormancy, increased with development and peaked at the time of flowering, and then became shorter. In spring and summer culture, tuber dormancy was the same as that in winter culture, but it was rather inconsistent among genotypes in the late stage of tuber development.

Floral initiation occurred when about 30 leaves were formed in any season in 'Misato Red' and 'Tropical Red'. In 'Rose Queen', however, floral initiation occurred when 47 leaves had formed in summer culture, and at about 35 leaves in winter and spring culture. This may be due to differences in response to temperature, especially high soil temperature which may inhibit floral initiation depending on the genotype. Once floral initiation occurred the flower bud developed rapidly in all culture season (Chetoshi *et al.,* 13).

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