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Effect of nutrients on quality planting material (tubers) production of Glory lily (*Gloriosa superba* L.)

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Abstract
The trial was conducted with the view of producing quality planting material in glory lily since the cost of planting material (tubers) is very high and tubers are sourced only from wild leading to serious depletion of genetic resources. The experiment was laid out in Randomized Block Design with 8 treatments and three replications, with two levels of FYM (10 and 25 t ha^{-1}) and three levels of recommended dose (125:50:75 kg of NPK ha^{-1}) of fertilizers (50, 75 and 100 per cent levels) and one organic treatment *viz*., vermicompost 2 t ha^{-1} + Humic acid (5 kg ha^{-1}). Observations were made on various morphological, biochemical and tuber yield attributes during various stages of growth. Fertilizer level of 25 t FYM /ha +100 % RDF registered higher plant height, tuber characters and biochemical constituent in tuber which was on par with 25 t FYM /ha +75 % RDF and 10 t FYM /ha +100 % RDF over the control. The methodology standardized will reduce the pressure of natural collections and will help the species to survive in wild.

Keywords: Micro tuber, Nutrient, Tuberisation, *Gloriosa superba,* Glory lily

Introduction
Glory lily or African climbing lily (*Gloriosa superba* L.) is a tall, weak-stemmed climbing annual, medicinal plant native to India. It is commercially cultivated in Tamil Nadu with annual exports upto 1000 tonnes valued Rs.120 crores. Tubers are collected from wild and used as planting material. There has been a serious biodiversity concern due to the over exploitation of the species from natural habitat. According to Sivakumar and Krishnamurthy (2002) [18], Gloriosa has been placed into the negative list of exports (tubers) on account of it's serious genetic depletion from wild. Even today, about 95% of the planting materials (tubers) are harvested from wild which has invited the attention of environmentalist and horticulturist to evolve non destructive methods of generating adequate propagules (Krishnamurthy, 2008) [8].
Although there is no precise data on volume of tubers required every year for planting, rough estimates on trade reveal that about 500 tonnes of tubers are required to take up new planting or to replace the old tubers every year. *Gloriosa superba* is conventionally propagated through tubers but seed propagation is another means so far under-utilized. Seed propagation though has limitations like high variability in seed population, lower germination percentage, and more time taken to produce flowers and seeds, it is considered as simple and least expensive (Sivakumar *et al.*, 2003) [19]. Moreover, the growth, flowering and pod set cycle are prolonged in seed progenies compared to that of tuber propagation as additionally supported by Krause (1986) [7].
On the other hand, although vegetative propagation of *Gloriosa* is commonly followed method, the cost of tubers are high and in the absence of any sustained multiplication system (from non-wild sources), there is eventuality of habitat threat, biodiversity loss besides adding burden on expenditure leading to profit loss to growers. There is an urgent need to evolve technologies for multiplication of tubers using seeds, which is considered to be a very simple process and involves minimum cost.

Materials and Methods
The present investigation was carried out during August, 2010 at Department of Medicinal and Aromatic Crops at Tamil Nadu Agricultural University, Coimbatore which is lying between 11 ^{0} 02' N and 76 ^{0} 57' E at an altitude of 426.76 m above MSL.

The field experiment comprised of 8 nutrient treatment combinations of two levels of FYM, three levels of NPK and vermicompost + Humic acid including the control. The design adopted was randomised block design with three replications.

The micro tubers were small bead sized mini tubers each weighing 1-2g in weight. These micro tubers were obtained by germinating the seeds of glory lily as per the method standardised by Anandhi *et al.* (2010) [1]. The method involved use of healthy and graded dry seeds of glory lily which were soaked in hot water and kept overnight in same water, and sown in a medium consisting of coco peat: red soil: sand at 1:1:1 ratio. Seedlings produced small micro sized tubers in first generation. These micro tubers weighing 1-2 grams were used as planting materials for this experiment to raise the second generation. As these tubers are not generally used for planting due to the smaller size, they require tuberisation and bulking to make it to a plantable size (>20g/tuber). These tubers in relation to different levels of fertilizers applied were field experimented to study their influence on tuberisation.

Prior to the experiment, soil samples were collected from the site at depths of 0-15 cm and 15-30 cm and analyzed in order to determine their physicochemical properties (Table 1). Micro tubers were planted at 15 x 15 cm distance. Morphological and yield parameters were determined *in-situ* from five randomly sampled and tagged plants per plots. Full dose of phosphorus in the form of single super phosphate was applied as single basal dose, pre-calculated quantities of nitrogen and potassium (T_2 to T_7), were given in three split doses at monthly intervals (Recommended dose of fertilizer: 125: 50: 75 Kg NPKha^{-1}). The crop was harvested at the third month (once the plant start drying above ground level and tubers entry to the dormancy period).The observations were recorded on growth attributes like plant height (cm), no of leaves (cm), at 60 and 90 DAP and yield parameters like tuber length (cm), tuber girth (cm), average tuber weight (g) and tuber yield /plot at harvest. Biochemical parameters like starch (Anthrone Method), protein (Lowry *et al*., 1951) [11] and colchicine (Ntahomvukiye *et al*. 1984) [14] were analysed from the tuber. The data collected in respect of various parameters on growth, tuber yield attributes were analysed statistically as described by Panse and Sukhatme (1985) [15].

Results and discussions

Growth attributes

Numerically more number of tubers sprouted (85.75 %) with the fertilizer level of 25 t FYM +100 % RDF ha^{-1} (T_7). The sprouting percentage was lowest (77.14 %) in control (T_1). This may be due to the differential amount of reserves stored in the tubers. Hidekazu *et al*. (1998) [3] reported that the size of the yam seed tuber used for propagation influenced both the degradation of reserves stored in the tuber as well as on eventual growth and development of the plant.

In micro tubers, the plant height ranged from 28.30 cm (T_1-control) to 35.69 in T_7 (25 t FYM + 100 % RDF). The increase in plant height may be due to the application of organic manure along with recommended dose of fertilizer which would have facilitated rapid and greater availability of plant nutrients and provided a better environment for root growth and proliferation. It might also had created more adsorptive surface for uptake of nutrients nd similar results were observed by Gangadharan and Gopinath (2000) [2], Kumar and Mishra, (2003) [9] and John *et al.*, (2007) [6].

Biochemical parameters

The starch, protein and colchicine content in tubers were found to be increased significantly with increased levels of fertilizers (Table 2). The increased levels in starch and protein content may be due to better photosynthates assimilated through leaves and physiological attributes. Plants supplied with high NPK fertilizer in growth stages maintained vegetative growth leading to higher photosynthetic area which in turn resulted in more accumulation of assimilates in sink. This is due to the fact that nitrogen supply which is related to carbohydrate utilisation would have enhanced protein synthesis allowing the plants to grow faster, Phosphorous application also would have helped the root crop in energy storage, transfer of ATP and ADP, development of structural components of nucleic acids. Potassium being an essential constituent would have helped formation of carbohydrate and translocation of starch resulting in improved plant height was reported by Yadav *et al.*, (2003) [20] and Jain and Verma (2003) [5].

Yield attributes

The highest tuber length (20.23 cm), tuber girth (3.19 cm), tuber weight (16.22 g) and tuber yield per plot (1102.62 g) was registered in T_7 (25 t FYM + 100% RDF) while the lowest tuber characters were recorded in control (T_1). It was evident that the average weight of tuber obtained in plants raised through micro sized tuber was 14.75 g (Table 3). This showed that there was an enhancement in bulking of tubers to the tune of six to seven times as compared to the original tubers used as planting (micro tuber 1-2 g). The enhancement in tuber weight may be due to the increase in tuber length and a very interesting observation made was that plants raised through micro tubers produced remarkable difference in tuber length between the control (13.32 cm) and T_7 (20.23 cm). This is due to the fact that micro tubers encouraged better initial and later growth rate of tuberisation and responded well to the applied fertilizers resulting in maximum attainment of tuberisation. The tuber yield per plot in plants raised through micro tubers was higher as the density of plants per unit area. This conclusion was supported by Memane *et al.* (2008) [13] in garlic, tuberose by Kumar *et al.*, (2003) [10], Malam *et al*., (2008) [12] and turmeric by Hossian *et al.*, (2005) [4].

Tuber development depends on moisture, climate under influence and nutrient availability. Application of 25 t FYM+100 per cent RDF increased the tuber length and weight when compared to the control. The high amount of organic manure applied to soil would have improved the soil moisture, facilitated high nutrient availability and permitted tuberisation. Singh and Bijimol (2000) [17] and Sehrawat *et al.* (2003) [16] also reported improvement in corm and cormel production in gladiolus with the increased NPK levels coupled with organic manure. Between the various fertilizer treatments, FYM- 25 t/ha + 100 % RDF registered the highest starch content (34.33 mg g.$^{-1}$) indicating the positive influence in higher starch accumulation.

Table 1: Properties of the soil at experimental site

S.NO	Particulars	Levels	Interpretation
1	pH	7.67	Slightly alkaline
2	Electrical conductivity (dSm^{-1})	0.46	Very low saline
3	Available nitrogen (kg ha^{-1})	232	Low
4	Available phosphorus (kg ha^{-1})	23.7	High
5	Available potassium (kg ha^{-1})	687	High

Table 2: Effect of nutrients on biochemical parameters of glory lily tubers

Treatments	Starch content (mg g^{-1})	Protein content (mg g^{-1})	Colchicine (%)
T_1 Control	21.42	1.74	0.306
T_2 FYM- 10 t/ha + 50 % RDF	22.59	1.96	0.319
T_3 FYM- 10 t/ha + 75 % RDF	23.94	2.2	0.324
T_4 FYM-10 t/ha + 100 % RDF	27.54	2.36	0.321
T_5 FYM- 25 t/ha + 50 % RDF	25.92	1.84	0.337
T_6 FYM- 25 t/ha + 75 % RDF	25.74	2.12	0.339
T_7 FYM- 25 t/ha + 100 % RDF	28.44	2.84	0.349
T_8VC- 2 t/ha + HA (5 kg ha^{-1})	24.21	2.68	0.327
CD (0.05%)	1.43	0.12	0.019
SED	0.66	0.05	0.009

(RDF- Recommended dose of fertilizer; VC- Vermicompost; HA- Humic acid)

Table 3: Effect of nutrients on germination, plant height and tuber characters

Treatments	Germination (%)	Plant height (cm)	Tuber length (cm)	Tuber girth (cm)	Tuber weight (g)	Tuber yield / plot (g)
T_1 Control	73.44	28.30	13.32	2.70	12.85	873.80
T_2 FYM- 10 t/ha + 50 % RDF	80.47	31.74	15.86	2.97	14.56	989.74
T_3 FYM- 10 t/ha + 75 % RDF	84.38	28.30	15.92	2.97	14.49	984.98
T_4 FYM-10 t/ha + 100 % RDF	82.81	31.26	16.89	3.19	15.06	1023.74
T_5 FYM- 25 t/ha + 50 % RDF	81.25	32.11	18.20	3.15	15.01	1020.68
T_6 FYM- 25 t/ha + 75 % RDF	78.91	34.27	18.98	3.17	15.17	1031.56
T_7 FYM- 25 t/ha + 100 % RDF	85.16	35.69	20.23	3.19	16.22	1102.62
T_8VC- 2 t/ha + HA (5 kg ha^{-1})	78.13	30.83	15.92	2.81	14.70	999.60
CD (0.05%)	4.45	1.78	0.98	0.17	0.83	56.76
SED	2.09	0.82	0.45	0.08	0.38	26.21

(RDF- Recommended dose of fertilizer; VC- Vermicompost; HA- Humic acid)

Conclusion

These micro tubers can be a better source of multiplication of tubers. Large scale multiplication using the protocol standardised can help in supply of quality planting material to farmers at low cost. The tubers generated from micro tubers and have to be field tested to confirm the flowering, pod set and seed yield. The methodology standardized will reduce the pressure of natural collections and will help the species to survive in wild.

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