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Different Levels of Nitrogenous Fertilizer Application for Growth, Flowering and Yield Attributes of Glori lily (*Gloriosa superba L.*)

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ABSTRACT

Field experiment were conducted at farmer's field, Devanur village, Ariyalur District of Tamil Nadu during 2008 to study the Different Levels of Nitrogenous Fertilizer Application for Growth, Flowering and Yield Attributes of glori lily. There were Five different treatments viz., Control (T0), 100 per cent recommended N (T1), 75 per cent recommended N (T2), 50 per cent recommended N (T3) and 25 per cent recommended N (T4). The treatments were replicated four adopting RBD design. The growth and yield attributes of glori lily viz., plant height, leaf area index, number of primary branches plant-1, number of secondary branches plant-1, number of tertiary branches plant1,drymatter production (kg ha-1), days to fifty per cent flowering, number of pods plant-1, number of seeds pod-1 and hundred seed weight (g), were favorably increased by the application of 100 per cent recommended N (T1). Seed and tuber yield (Kg ha-1) were greatly increased and the maximum seed and tuber yield were recorded. The uptake of NPK by glori lily was significantly increased by the above treatment combination. Application of 100 per cent recommended N (120 kg ha-1) (T1) gave the highest Gross income, Net income and return per rupee invested. Based on the above results, it can be concluded that inorganic use of 100 per cent recommended N (120 kg ha-1) is found to be an appropriate agro-technique for augmenting the productivity and profitability of glori lily without altering the soil fertility. It is a basic constituent in all proteins, enzymes, chlorophyll, certain parts

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of nucleus and hormone. The supply of nitrogen is related to carbohydrates utilization for growth and development process.

Key words:
Nitrogenous Fertilizer, Growth, Flowering and Yield Attributes of Glori lily, Economics, Uptake and postharvest soil nutrient status.

INTRODUCTION

India is a rich wealth of Medicinal plants, which have contributed to the development of ancient Indian materia medica. In one of the earliest treatises on Indian medicine, the charak, samhita (1000 B.C.) records the use of over 840 drugs of plant origin. Even though there has been a tremendous development in the field of synthetic drugs and antibiotics during the recent years, plants still remain one of the major sources of drugs in traditional as well as in modern medicine throughout the world. *Gloriosa superba* L. belongs to the family Liliaceae, being locally called as “Kanvali kizhangu” or Karthigai kizhangu” or Kalappai kizhangu (or) “Kanthazh” in Tamil. It resumes new growth by July-September and produces flowers during October-November[1]. It is a native to tropical Asia and Africa and found growing throughout tropical India upto an altitude of 2500 m[2]. Commercial cultivation of this crop is mostly confined to the Southern states of India[3]. The medicinal value of glory lily is commendable which is attributed to the presence of alkaloids, chiefly ‘colchicine’ (C_{22} H_{25} O_6 N MP – 151-152°C) and ‘Gloriosine’ (C_{22} H_{25} O_6 N MP – 248 - 250°C). Recently, a new alkaloid namely 1, 2 Dimethyl colchicine has been isolated from seeds[4]. Colchicine extracted from the tubers and seeds are used in the treatment of ‘gout’ and ‘rheumatism’. It is also used by breeders to induce polyploidy in crop plants. Gloriosine is also reported to possess polyploidizing effect, even with greater magnitude than colchicine[5].

The drug extracted from the seed is bitter, pungent and astringent in taste. In Ayurvedic system of medicine, the underground rhizomes are used since ancient times as an anthelosintic, anti-inflammatory and anti-leprotic. The drug from the tuber is a gastro-intestinal irritant and may cause vomiting or purging. It is useful in demotosis, piles, chronic ulcers, colic pain and as a cataplasm in neuralgic pains. The white starchy powder made from the tubers after washing with water is used in the treatment of gonorrhoea and the leaf juice is used for killing head lice. The underground stocks have been used as an abortifacient and hence the name “Garbhaghatini.” The tubers are administered to cattle for expulsion of worms and also used as an adulterate of Aconite[6].

Colchicine was extracted from the root cultures following the methods of Hayashi *et al.* [7]. The roots were harvested, dried and powdered and then extracted for 6 hr. in a Soxhlet extractor with methanol. The extract was diluted with distilled water partitioned against n-hexane and finally the aqueous phase containing colchicine was extracted with chloroform. Liquid medium was extracted with chloroform (1:2, v/v) under continuous shaking at room temperature for 2 hr. The chloroform extract was separated from aqueous phase by a separating funnel. Chloroform extracts were evaporated to dryness and the residue was dissolved in 1 ml HPLC grade methanol, filtered through 0.22 µm filter and subjected to HPLC following the method reported earlier[8].

The drug has so far been obtained from collection from wild sources but of late, the indiscriminate exploitation of tubers has affected its supply badly. This has necessitated establishment of commercial plantations to meet the demand of pharmaceutical industries. At present, glory lily cultivation in India is confined to states like Tamilnadu and Goa. In Tamil Nadu, the cultivation has recently spread in isolated pockets in the districts of Salem, Erode, Dharmapuri, Nagapattinam, Dindukal and Ariyalur. Being a newly domesticated crop, the appropriate production technologies for this medicinal plant have not yet been standardized on a scientific footing. Nitrogen is an essential nutrient element to promote vigorous growth and its ample supply ensures normal growth with optimum plant height, leaf area index, number of pods, number of seeds pod^{-1} and seed yield.

With this background in view, the present investigation on *Gloriosa superba* L. was undertaken with the following objectives.

1. To study the effect of different levels of nitrogen on growth, flowering and yield attributes of Glori lily.
2. To study the effect of nutrient management practices on N, P and K uptake kg ha^{-1}.

3. To study the post harvest nutrient status of soil on N, P and K kg ha^{-1}.

4. To work out the economics of inorganic nutrient management practices.

Review of Literature

Glori lily is one of the important plants which have attained economic significance in recent times. The medicinal worthiness of this species has been well established in curing various ailments in the traditional Ayurvedic system of medicine since ancient times[9]. Glorilily is highly valued in modern medicine too owing to the presence alkaliods, mainly colchicine. It is used in the treatment of gout, cancer, cholera, typhus, brigades disease, colic and skin complaints[10,11]. The percentage of Colchicine in seeds is ten times more than that in the tubers [12]. The rhizomes of this plant have been used in traditional Indian medicine for many purposes [13]. Despite this, very little research work has been attempted in this crop towards standardizing production technology including use of inorganic nutrient sources. Hence, an attempt has been made to review the related literature on the effect of different levels of N on the growth and yield of Glori lily.

Effect of inorganic nitrogen on growth and yield

Nitrogen is an essential nutrient element to promote vigorous growth and its ample supply ensures normal growth with optimum plant height, leaf area index, number of pods, number of seeds pod^{-1} and seed yield. It is a basic constituent in all proteins, enzymes, chlorophyll, certain parts of nucleus and hormone. The supply of nitrogen is related to carbohydrates utilization for growth and development process. When nitrogen supply is adequate proteins are formed from the manufactured carbohydrates[14].

Singh and Duhan[15] reported that application of 100 kg N ha^{-1} significantly increased the herbage and oil yield of *Mentha piperita*.

Gupta and Pareek [16] reported that N at 40 kg ha^{-1} gave higher total alkaloid content in both the periwinkle roots and leaves over control.

Singh *et al.*[17] reported that the plant height, leaf area index, and leaf stem ratio were increased significantly with nitrogen up to 150 kg ha^{-1} in mint species.

Rao *et al.* [18] studied the effect of N and method of harvesting on herbage and essential oil yield in geranium. The best result with regard to essential oil content and yield were obtained with 100 kg N ha^{-1}.

In turmeric, yield increased significantly at the dosage of 150 kg nitrogen ha^{-1}. Maximum finger weight (380 g and 382 g plant^{-1}), finger size (4.3 x 7.4 cm and 7.4 x 7.6 cm) and highest turmeric yield (23.7 t ha^{-1} and 24.3 t ha^{-1})were also obtained by application of 150 kg N ha^{-1} in both the years of study was reported by Power and Gavande[19].

Ashok Kumar and Prasad [20] and Sharma and Kakati [21] stated that the seed yield in sesame increased with increasing dose of nitrogen. Chandrakar *et al.*[22] reported that application of 150 kg Nitrogen ha^{-1} was most profitable for sesame crop. The results of Ishwar Singh *et al.* [23], Sharma *et al.* [24] and Dixit, *et al.* [25] were also in confirmation with the above findings.

Moorthy *et al.* [26] observed that increased dose of Nitrogen above 75 kg ha^{-1} was optimum for sesame.

In *Gloriosa superba,* Kumaraswamy *et al.* [27] found that nitrogen application had favourable effect in enhancing vegetative growth and prolonged the crop duration, seed yield and components increased with increase in the dose of nitrogen from 160 kg N ha^{-1}.

Banafor and Tiwari [28] reported that with the increase in N levels, the growth, leaves number, tiller number and rhizome yield increased in turmeric.

Bhaskar [29] reported that application of N at 200 kg ha^{-1} for Patchouli gave 93 tonnes of fresh herbage yield ha^{-1} but it was on par with 150 kg N ha^{-1}.

Muniram and Sushilkumar [30] reported that application of 100 kg N ha^{-1} resulted in maximum herbage and essential oil yield in Palmarosa. Rao *et al.* [25] suggested that application of 80 kg N ha^{-1} significantly enhanced the biomass production and essential oil in Davana.

Bambal *et al*. [31] observed that in cauliflower, application of 100% N along with biofertilizers significantly increased chlorophyll content (1.48 mg / g), leaf area (634.58 sq. cm / plant) and yield (29.64 mg/ha).

Singh[32] found that out of four levels of nitrogen tried (0, 25, 50 and 75 kg N ha^{-1}), application of 50 kg N ha^{-1} gave optimum herbage and oil yield on geranium compared with that of control and other levels.

Mann and Vysa [33] observed that plant height, leaves plant^{-1} and dry matter accumulation were significantly

increased upto 45 kg N ha^{-1} and N, P and K uptake was also enhanced by the highest level of Win Isabgol.

In gloriosa, a closely related species 15-20% of the N required by the developing sprout and tuber are supplied by the mother tube, N (application rates – 14.2, 28.4, 56.7, 113.6 and 227.2 g N/m^2) which translocates 80-90% of its N stored [34].

Singh[52] reported that application of 140 kg N ha^{-1} increased plant height (56.92 cm), leaf length (50.22 cm), leaf width (19.65 cm), curd diameter (16.15 cm), curd depth (9.59 cm), net curd weight (651.45 g) and marketable curd yield (208.46 g ha^{-1}) of cauliflower. Kuldeep Singh *et al*. [35] opined that in cauliflower, application of 180 kg N ha^{-1} increased the plant height (51.72 cm), no. of leaves $plant^{-1}$ (21.49), plant spread (1989, 83 sq. cm), leaf area (987.62) and total marketable yield (317.11 g ha^{-1}).

Application of N @ 120 kg ha^{-1} recorded the maximum yield of 188.04 g ha^{-1} in onion [36]. Jambukar and Wange (2005)[51] observed that application of N @ 75 kg ha^{-1} along with biofertilizer in sugarbeet showed significant number (42), fresh weight (462.40 g) and dry weight (61.31 g) of leaves $plant^{-1}$.

The turmeric plant height, leaves number, finger weight, finger size and turmeric yield were influenced by N application. It was also found that with the increment of N levels, all the yield contributing parameters increased progressively, upto 150 kg nitrogen ha^{-1}. The highest plant height (10 cm and 102.3 cm) leaves number (9.9 and 10.9 $plant^{-1}$) and the highest finger per plant (42.4 and 43.7) were recorded when 150 kg N ha^{-1} was applied [37].

N applied alone or in combination with P, K resulted in a significantly higher turmeric plant height of 153.6 cm and leaf number 34 $plant^{-1}$ and tillers of 5.2 $plant^{-1}$. N is the principal nutrient of plant, which significantly increased vegetative growth parameters of turmeric than any other nutrients [38].

MATERIALS AND METHODS

Field Experiment was conducted to study the effect of inorganic nutrients on the growth, flowering and yield of Glory lily (*Gloriosa superba* L.) during 2008 under rainfed conditions at the farmers' field, Devanur village, Ariyalur district of Tamil Nadu. The details of materials used and methods adopted during the experimentation are furnished in this chapter.

Materials

Location of the Experimental Field

Devanur is located at an elevation of 65 m above MSL, at a latitude of 11°14′ N and longitude of 79°18′ E).

Weather and Climate

The mean maximum temperature is 32.2°C and the mean minimum temperature is 21.5°C. The mean annual rainfall is 946 mm, of which 670 mm is received during North-East monsoon (Oct.–Dec.), 220 mm during South-West monsoon (June – Sept.) and 56 mm as summer showers (March – May). The mean relative humidity is 72 per cent.

Soil

The soil was red loamy soil texture, low in available nitrogen, medium in available phosphorus and high in available potassium. The details of soil analysis are furnished is Table 1.

Crop and Variety

The "Red Kandha malar" variety of *Gloriosa superba* L. is used for the field experimentation.

METHODS

Design of the experiment

The experiment was laid out in RBD design with four replications. Five plants in each treatment were marked for periodical observation.

Experimental details

Season: July –Dec 2008

Plot area: 5.0 m x 4.0 m

Date of sowing / planting: 20.07.08

Date of harvest: Dec-2008

Treatment details

The treatment details are furnished below.

Treatment details

T_0 - Absolute control (Organic manure)

T_1 - 100% Nitrogen (120 kg ha^{-1})

T_2 - 75% nitrogen (90 kg ha^{-1})

T_3 - 50% nitrogen (60 kg ha^{-1})

T_4 - 25% nitrogen (30 kg ha^{-1})

The nitrogen (N) was supplied through urea. A common dose of 50 kg P_2O_5 and 75 kg K_2O ha^{-1} was followed.

Cultural Practices

Different cultural practices adopted are detailed below.

Field Preparation

The experimental area was ploughed with a tractor and leveled. Trenches of 30 cm wide, 30 cm deep and length of 100 m were formed at a spacing of 100 cm and the plant to plant spacing was kept as 30 cm.

Collection and Preparation of Seed Tubers

Healthy Gloriosa tubers of uniform size were procured from a farmer cultivating glory lily at Elamangalam. The tubers were transported carefully without damaging the sprouting buds and stored temporarily in thick layer of river sand in a cool dry shady place. Uniformly sized (50-60 g) healthy tubers with good growing tips were selected for planting.

Irrigation

The plots were irrigated once in 3 days during the initial stages of sprouting.

Staking

Each plant was individually staked in such a way that the growing tips trail on them.

Weeding and Plant Protection

Need based weeding and plant protection measures were taken.

Biometric Observations

Observations on different characters were recorded on five plants in each treatment and the mean was worked out.

Growth Attributes

Plant height

The plant height was recorded at 60, 90 and 150 days after planting from the ground level to the tip of the main branch when held vertically and expressed in cm.

Number of primary branches per plant

The number of branches present on the main stem at the time of final harvest was counted and recorded.

Number of secondary branches per plant

The number of branches on each primary branches at the time of final harvest was counted and recorded.

Number of tertiary branches per plant

The number of branches on each secondary branches at the time of final harvest was counted and recorded.

Leaf area index (LAI)

The total number of leaves present at three stages viz. 60, 90 and 150 days was counted and recorded.

$$LAI = \frac{\text{Leaf area}}{\text{ground area}}$$

This parameter was calculated by taking the maximum length and width of leaf and by using the formula LA = L x B x F as suggested by Carow[39]. The factor (F) used was 0.54 and leaf area was recorded at three stages viz., 60, 90 and 150 days.

Dry matter production

One representative plant from each plot was uprooted at harvest stage and samples were oven-dried at 80 ± 5°C for 48 hours till a constant weight was recorded. The dry matter weight ha^{-1} was computed and expressed in DMP kg ha^{-1}.

Flowering, Fruit Set and Pod Characters

Days to Fifty per cent flowering

The number of days taken to produce 50 per cent flowering was recorded.

Length of pod

The length of ten pods from each plot was measured from the base to the tip and their mean was expressed in cm.

Harvest

As and when the pods mature, harvesting was done.

There were altogether 5 pickings in a total crop period of 160 days.

Yield Attributes

Number of pods per plant

The total number of pods harvested per plot was counted and recorded.

Number of seeds per pod

Ten pods were randomly selected from each plot and the number of seeds in each pod was counted and the average seed number per pod was worked out.

Hundred Seed weight

This was recorded by weighing 100 seeds in each treatment from the composite sample and their average was worked out and expressed in gram.

Seed yield per hectare

The total yield of seeds per plot was recorded by adding the seed yield of individual plants in each plot and recorded in gram. From the value of plot yield, the yield per hectare was estimated and expressed in kilogram.

Fresh weight of tubers

The tubers were carefully dug out after the final harvest from each plot and were weighed and the weight was expressed in kilogram per hectare.

Economic analysis

Based on the prevailing market rates, the gross return per hectare was worked out. The net return was calculated by deducting the expenditure from gross return. The benefit cost ratio (B : C ratio) was worked out by dividing the gross return by expenditure incurred.
Net return = Gross return – Cost of cultivation

$$\text{B : C ratio} = \frac{\text{Gross return (Rs. ha}^{-1}\text{)}}{\text{Cost of cultivation (Rs. ha}^{-1}\text{)}}$$

Soil Analysis

Pre-planting and post-harvest soil samples were taken from each plot at 0-45 cm depth. The samples were shade dried and passed through 2 mm sieve. The samples were analysed for various physico-chemical characteristics.

Mechanical analysis

The mechanical composition of the soil was analysed by International pipette method described by Piper [40].

Soil pH and EC

The soil solution was prepared with water at 1:2 (soil: water) ratio. The soil pH was estimated using Elico pH meter as per the procedure described by Jackson [41]. The EC was measured in the 1:2 water suspension with Elico-conductivity meter [41].

Organic matter

The organic carbon content was determined by the method suggested by Walkley and Black [42]. It was computed to organic matter by multiplying with the factor 1.724 and expressed in percentage.

Available nitrogen

The available nitrogen was estimated by alkaline permanganate method (Subbiah and Asija, 1956)[43] and expressed in kg ha^{-1}.

Available phosphorus

The available phosphorus was estimated by the method described by Olsen *et al.* (1954)[44] and expressed in kg ha^{-1}.

Available potassium

The available potassium was determined by neutral normal ammonium acetate extract using flame photometer [41].

Plant Analysis

Nutrient uptake by crop

The sample plants collected for biomass estimation at harvesting were analysed for N, P and K nutrient content. The percentage of nutrient in the plant was multiplied by crop biomass and nutrient uptake was expressed in kg ha^{-1}.

Nitrogen

Total nitrogen content in crop was estimated by Macro-kjeldahl method suggested by Yoshida *et al.* (1976)[45] and computed to kg ha^{-1}.

Phosphorus

The phosphorus content of the plant sample was es-

Table 1. Physico-chemical properties of the soil

	Particulars	Value
A.	Mechanical analysis (Piper,1966)	
1	Coarse sand (%)	36.62
2	Fine sand (%)	14.29
3	Silt (%)	12.01
4	Clay (%)	16.21
5	Textural class	Red loam
B,	Chemical analysis	
1	Organic matter (%) (Walkley and Black, 1934)	0.7
2	Organic carbon (%) (Walkley and Black, 1934)	0.41
3	Soil reaction (pH) (Jackson, 1973)	6.5-7
4	Electrical conductivity (dSm-1) (Jackson, 1973)	0.1
5	Available 'N' kg ha-1 (Subbiah and Asija, 1956)	231.39
6	Available 'P2O5' kg ha-1 (Olsen et al. 1954)	16.82
7	Available 'K2O' kg ha-1 (Stanford and English, 1949)	293.68

Table 2. Effect of different levels of nitrogen on plant height (cm) of glori lily.

Treatment	60 DAP	90 DAP	Harvest Stage
T_0	125.33	153.66	163.00
T_1	158.66	191.00	221.33
T_2	153.66	187.33	217.33
T_3	144.66	185.33	205.66
T_4	136.66	168.33	174.66
Mean	145.80	181.13	207.80
$S.E_D$	2.25	1.80	2.00
CD(P = 0.05)	4.50	3.60	4.00

Table 3. Effect of different levels of nitrogen on leaf area index of glori lily

Treatment	60 DAP	90 DAP	Harvest Stage
T_0	0.23	0.47	0.49
T_1	0.27	0.69	0.78
T_2	0.25	0.66	0.74
T_3	0.24	0.54	0.69
T_4	0.25	0.48	0.52
Mean	0.25	0.57	0.64
$S.E_D$	0.01	0.01	0.02
CD (P = 0.05)	0.02	0.03	0.04

timated by triacid digestion method as described by Jackson [41] using Spectrophotometer and computed to kg ha^{-1}.

Potassium

The potassium in the plant samples was estimated by triacid digestion method as described by Jackson [41] using Flame photometer (Model: Elico-digital CL 220) and computed to kg ha^{-1}.

Statistical Analysis

The experimental data were statistically analysed with the methods described by Panse and Sukhatme[46]. For significant results the critical difference was worked out at 5 per cent probability to draw statistical conclusions.

RESULTS

The results of the field experiments conducted at farmers' field, Devanur village, Ariyalur District of Tamilnadu during 2008 to study the effect of inorganic nitrogen fertilizers on the growth, flowering and yield of glori lily are presented in this chapter.

Growth Attributes

Plant height

The observation was recorded on plant height at 60, 90 and harvest stage are furnished in Table 2. The plant height at different growth stages showed significant variations. Among the treatments, application of 100 per cent N (T_2) recorded the highest plant height of 158.66, 191.00and 221.33 cm at 60, 90 and at harvest respectively. The least plant height of 125.33, 153.66and 163.00 cm was noticed under T_1 (control).

Leaf Area Index

The observations recorded on LAI at 60, 90 at harvest are furnished in Table 3.

Among treatments, application of 100 per cent recommended N, (T_2) recorded the highest LA of 0.27, 0.69 and 0.78 at 60, 90 and at harvest respectively. The least LAI of 0.23, 0.47 and 0.49 at 60, 90 and at harvest respectively was recorded under control (T_1).

Number of Primary Branches Plant^{-1}

The observations recorded on number of primary branches plant^{-1} at 60, 90 and at harvest are furnished in Table 4.

Among the treatments, application of 100 per cent recommended N (T_2) recorded the highest number of primary branches plant^{-1} of 4.33, 4.66 and 5.00 at 60, 90 and harvest, respectively. The least number of branches plant^{-1} of 3.00, 3.66 and 4.00 at 60, 90 and harvest respectively was recorded in control treatment (T_1).

Number of Secondary Branches Plant^{-1}

The observations recorded on number of secondary branches plant^{-1} at 60, 90 and at harvest are furnished in Table 4.

Among the treatment, 100 per cent recommended N (T_2) recorded the highest number of secondary branches plant^{-1} of 15.00, 18.00 and 20.66 at 60, 90 and harvest, respectively. The least number of branches plant^{-1} of 10.66, 13.66 and 15.66 at 60, 90 and harvest, respectively was recorded under control (T_1).

Number of Tertiary Branches Plant^{-1}

The observations recorded on number of tertiary branches plant^{-1} at 90 and at harvest are furnished in Table 4.

Among the sub-plot treatments, application of 100 per cent recommended N (T_2) recorded the highest number of branches plant^{-1} of 22.00 and 25.00 at 90 and harvest, respectively. The least number of branches plant^{-1} on 14.66 and 17.00 at 90 and harvest respectively was recorded under control (T_1).

Dry matter production (DMP)

The data recorded on dry matter production (kg ha^{-1}) at harvest stage are presented in Table 8 and Fig. 5.

Among the sub-plot treatments, application of 100 per cent recommended N (T_2) recorded the highest DMP of 13609.49 kg ha^{-1} at harvest. The least DMP of 11966.76 kg ha^{-1} at harvest was recorded under control (T_1).

Flowering, Fruit Set and Pod Characters

Days to Fifty per cent flowering

The observations on days taken to fifty per cent flowering are presented in Table 6.

There was significantly influenced on days to 50 per

Table 4. Effect of different levels of nitrogen on primary, secondary and tertiary branches (plant^{-1}) of glori lily

Treatment	Primary Branches (plant^{-1})			Secondary Branches (plant^{-1})			Tertiary Branches (plant^{-1})	
	60 DAP	90 DAP	Harvest Stage	60 DAP	90 DAP	Harvest Stage	90 DAP	Harvest Stage
T_0	3.00	3.66	4.00	10.66	13.66	15.66	14.66	17.00
T_1	4.33	4.66	5.00	15.00	18.00	20.66	22.00	25.00
T_2	3.33	4.33	4.50	12.00	17.00	19.33	19.00	23.00
T_3	3.66	4.00	4.33	12.00	16.00	18.00	21.66	22.66
T_4	3.00	3.33	4.00	12.00	14.33	16.00	18.00	19.33
Mean	3.46	4.00	4.13	12.33	15.60	15.93	19.06	21.40
$S.E_D$	0.45	0.15	0.75	1.50	1.00	0.66	1.50	1.00
CD(P = 0.05)	0.90	0.33	1.50	3.00	0.50	1.33	3.00	2.00

Table 5. Effect of different levels of nitrogen on DMP kg ha^{-1} of glory lily

Treatment	Harvest Stage DMP kg ha^{-1}
T_0	11966.76
T_1	13609.49
T_2	13315.78
T_3	12592.57
T_4	12370.50
Mean	12771.02
$S.E_D$	46.00
CD (P=0.05)	92.00

Table 6. Effect of different levels of nitrogen on fifty per cent flowering, Pod length (cm) of glori lily

Treatment	Fifty per cent flowering	Length of Pod (cm)	Number of pods plant^{-1}	Number of seeds pod^{-1}	Hundred seed weight (Gram)
T_0	65.66	7.83	18.45	40.15	2.08
T_1	68.66	10.00	21.62	48.26	2.51
T_2	67.66	9.00	20.92	46.56	2.41
T_3	66.66	8.50	20.75	44.30	2.38
T_4	66.00	8.66	20.05	42.43	2.18
Mean	67.33	8.80	20.36	44.34	2.31
$S.E_D$	0.50	0.50	0.35	0.85	0.05
CD (P = 0.05)	1.00	1.00	0.70	1.70	0.10

cent flowering due to different treatments. Among the treatments, application of 100 per cent recommended N (T_2) observed the earliest flowering (68.66 days). The delayed flowering (65.66 days), was observed when no N was applied (T_1). The delayed flowering (66.66 days) was observed in the treatment of 50 per cent recommended N,(T_4),

Length of Pod (cm)

The observations on length of pod at harvest are presented in Table 6. Among the treatments, application of 100 per cent recommended N (T_2) recorded the highest pod length of 10.00 cm. The least pod length of 7.83 at harvest was recorded under control (T_1).

YIELD ATTRIBUTES

Number of pods plant^{-1}

The data recorded on the number of pods plant^{-1} at harvest are presented in Table 6. Among the treatments, application of 100 per cent recommended N (T_2) recorded the highest number of pods plant^{-1} of 21.62 at harvest and it was on par with T_3 (75 per cent recommended N), which recorded the pod number plant^{-1} of 20.92 at harvest. The least pod number of 18.45 at harvest was recorded by control (T_1).

Number of Seeds pod^{-1}

The data on number of seeds pod^{-1} are presented in Table 6. Among the treatments, application of 100 per cent recommended N (T_2) recorded the highest number of seeds pod^{-1} of 48.26. It was followed by 75 per cent recommended N (T_3), which recorded 46.56 seeds pod^{-1}. The least number of seeds pod^{-1} of 40.15 was recorded under control treatment (T_1).

Hundred Seed weight test weight (g)

The data on hundred seed weight (test weight) are presented in Table 6. Among the treatments, application of 100 per cent recommended N (T_2) recorded the highest seed weight of 2.51 g. The least hundred seed weight of 2.08 g was observed in control (T_1).

Seed yield (kg ha^{-1})

The data on seed yield (kg ha^{-1}) are presented in Table 7.

Among the treatments, application on 100 per cent recommended N (T_2) recorded the highest seed yield of 791.28 kg ha^{-1}. The least seed yield of 512.65 kg ha^{-1} was recorded under control (T_1).

Fresh Tuber Yield (kg ha^{-1})

The data on fresh tuber yield (kg ha^{-1}) recorded at harvest are presented in Table 7. Among the treatments, application of 100 per cent recommended N (T_2) recorded the highest tuber yield of 2380.50 kg ha^{-1}. The least tuber yield of 1828.40 kg ha^{-1} was observed under control N, (T_1).

Crop Nutrient Uptake

The data recorded on nutrient uptake by crop are presented in Table 8. Among the treatments, application of 100 per cent recommended N (T_2) excelled other treatments. This treatment recorded the highest nutrient uptake of 115.38, 34.16 and 105.44 kg of N, P_2O_5 and K_2O ha^{-1} respectively.

The lowest NPK uptake of 109.76, 31.37 and 96.78 kg ha^{-1} respectively was recorded under control (S_1).

Post Harvest Soil Analysis

Available nitrogen (kg ha^{-1})

The data on post harvest available soil N status are furnished in Table 9. Among the treatments, application of 100 per cent N T_2 (120 kg ha^{-1}), recorded the least available post harvest soil NPK of 216.74, 15.82 and 283.81 kg ha^{-1}. The highest post harvest soil NPK of 231.39, 17.83 and 293.68kg ha^{-1} was recorded under control (T_4).

Economics

The details on cost of cultivation, gross return ha^{-1}, net return ha^{-1} and return rupee^{-1} invested for the crops are furnished in Table 10. The treatment T_2 (100 per cent N), performed better the other treatment combinations and recorded the highest net return of Rs. 1288024.07 ha^{-1}. This treatment also recorded the return per rupee invested of Rs. 4.62. The treatment combination T_1 (control), recorded the least net return of Rs. 87023.02 ha^{-1} and return per rupee invested of Rs. 3.96.

Discussion

Field experiment was carried out at the farmer's field, Devanur village, Ariyaur District of Tamil Nadu to study the effect of inorganic fertilizers on the growth and yield of glori lily. Five levels of N were tested. The results of the experiment conducted are discussed in this chapter.

Growth Characters

Table 7. Effect different levels of nitrogen on seed yield and tuber yield (kg ha^{-1}) of glori lily

Treatment	Seed Yield (kg ha^{-1})	Fresh tuber yield (kg ha^{-1})
T_0	512.65	1828.40
T_1	791.28	2380.50
T_2	781.72	2353.88
T_3	728.38	2165.15
T_4	617.70	2011.31
Mean	686.34	2147.85
$S.E_D$	4.78	13.31
CD (P= 0.05)	9.56	26.62

Table 8. Nitrogen, Phosphorus and Potassium uptake (kg ha^{-1})

Treatment	Nitrogen uptake (kg ha^{-1})	Phosphorus uptake (kg ha^{-1})	Potassium uptake (kg ha^{-1})
T_0	109.76	31.37	96.78
T_1	115.38	34.16	105.44
T_2	110.19	31.25	105.00
T_3	108.29	31.22	104.22
T_4	75.831	29.69	102.51
Mean	107.89	31.54	102.47
$S.E_D$	2.59	1.45	0.22
CD(P=0.05)	5.19	2.91	0.44

Table 9. Post harvest soil available NPK (kg ha^{-1})

Treatment	Nitrogen uptake (kg ha^{-1})	Phosphorus uptake (kg ha^{-1})	Potassium uptake (kg ha^{-1})
T_1	219.07	16.95	279.47
T_2	216.74	15.82	283.81
T_3	217.03	16.62	286.69
T_4	231.39	17.83	293.68
T_5	221.84	16.83	287.66
Mean	221.21	17.50	286.26
$S.E_D$	0.14	0.40	1.44
CD (P = 0.05)	0.29	0.80	2.88

The results showed that application of 100 per cent recommended N (120 kg ha^{-1}) excelled other levels by recording the highest plant height, number of branches $plant^{-1}$, LAI and DMP. The least growth component was observed in 25 per cent recommended N (30 kg ha^{-1}). Nitrogen is the chief promoter of growth and it is the element responsible for developing a good vegetative frame which is most responsible for yield components. This might be due to more availability of nutrient to the crop plants at higher levels. The result of the study confirms the findings of Haque *et al*. [37] that turmeric plant height, tiller number and LAI increased due to application of different levels of inorganic Nitrogen.

The least growth components were reported under 25 per cent recommended N applied treatments. This might be due to reduced supply of nutrients through inorganic sources to the crop which restricted the growth of crop. Similar findings were also reported by Kumaraswamy *et al*. [27].

Flowering

In general, the present investigation showed that application of 100 per cent recommended inorganic N (120 kg ha^{-1}) enhanced flower production and reduced the days taken to fifty per cent flowering. This might be due to the favorable effect of nitrogen sources. The result of present study was in close conformity with the findings of Darley Jose [47] in brinjal and Subbiah[48] in tomato.

Yield Attributes and Yield

Yield in general is a highly complex parameter influenced by the treatments; application of 100 per cent recommended N (T_1) attained superiority over others with regard to yield attributes viz., number of pods $plant^{-1}$, number of seeds pod^{-1}, and hundred seed weight. The result of the study confirms the findings of Haque *et al.* [37].

Tuber Yield

Tuber being the principal propagating material in gloriosa, has a commercial significance. Any treatment that would favorably alter the tuber size and yield will be advantageous in the farmers' point of view. Among the four levels of N tested as treatments, application of 100 per cent recommended N (T_1) was found to enhance the tuber production and tuber yield. Similar finding of increased rhizome yield in turmeric was reported by Haque *et al*.[37].

Crop Nutrient Uptake

Increased uptake of N, P, K at harvest stages was observed with the application of 100 per cent recommended N (T_1). This might be due to better nutritional environment through cumulative effect of inorganic source of nutrients. The results of the present study confirms the findings of Jadhav *et al.* [49] that considerable increase in the uptake of nutrients due to increased nutrient availability and higher dry matter accumulation.

Post Harvest Soil Available Nutrient Status

The treatment of 50 per cent recommended N (T_4) exerted a favorable influence on the available nitrogen, phosphorus and potassium in the post harvest soil. This might be due to higher soil available nutrient status under fertilizer N application. Similar finding of increased post harvest NPK status due to nutrient source in rice crop was reported by Jackson[41].

Economics

Application of 100 per cent recommended N (120 kg ha^{-1}, T_1) registered the highest net return of Rs. 1288024.07 and higher return $rupee^{-1}$ invested of Rs. 4.62, respectively. Application of 75 per cent recommended N (T_3) was found to be next in terms of net return and return $rupee^{-1}$ invested. Increased availability of nutrients with use of 100 per cent N increased the crop growth characters, yield attributes, seed yield and tuber yield might be the reason for higher gross income, net income and BCR. Similar findings of higher net income and BCR due to N application on maize were reported by Tolessa and Friesen [50].

Summary and Conclusion

Field experiment was conducted at the farmer's field Devanur village, Ariyalur District of Tamil Nadu during 2008 to study the effect of inorganic fertilizers on the growth and yield of glori lily.

Five levels of N viz., control (T_0), 100 per cent recommended N (T_1 - 120 kg ha^{-1}), 75 per cent recommended N (T_2 - 90 kg ha^{-1}), 50 per cent recommended N (T_3 - 60 kg ha^{-1}), and 25 per cent recommended N (T_4 - 30 kg ha^{-1}) were tested as treatments. The treatments were replicated four adopting RBD design. The salient findings of the investigation are summarized below.

Table 10. Economic Analysis

Treatment	Seed yield (kg ha^{-1})	Tuber yield (kg ha^{-1})	Total cost of cultivation (Lakh Rs. ha^{-1})	Gross return (Lakh Rs. ha^{-1})	Net return (Lakh Rs. ha$^{-1)}$	Return per rupee invested
T_0	512.65	1828.40	293467.98	1163700	87023.02	3.96
T_1	791.28	2380.50	360061.93	1663686	1288024.07	4.62
T_2	781.72	2353.88	374615.88	1644228	1269612.12	4.38
T_3	728.38	2165.15	355732.16	1523601	1149868.84	4.28
T_4	617.70	2011.31	350043.03	1344633	974589.97	4.00
$S.E_D$	4.78	13.31				
CD(P = 0.05)	9.56	26.62				

(Cost of Tuber @ Rs. **300** kg^{-1}, Seed @ Rs. **1200** kg^{-1})

ANNEXURE - I

Weather data during the crop period (July to Dec-2008)

Standard week	Period	Temperature (ºC)		Relative Humidity (%)	Rainfall (mm)	Rainy day
		Maximum	Minimum			
30	July 23-29	34.4	25.5	78	025.0	1
31	30-Aug5	35.0	25.3	80	042.0	1
32	6-12	35.3	25.5	75	007.8	-
33	13-19	33.8	24.0	80	001.0	-
34	20-26	34.2	24.1	85	005.4	-
35	27-Sep2	33.0	25.3	80	003.0	-
36	3-9	32.5	25.0	80	04.0	-
37	10-16	33.7	24.9	75	000.0	-
38	17-23	34.9	24.5	80	005.4	-
39	24-30	34.4	25.5	80	000.0	-
40	Oct1-7	33.8	24.9	80	002.0	-
41	8-14	32.2	24.1	81	005.8	-
42	15-21	29.4	24.2	85	170.0	6
43	22-28	30.0	24.0	93	020.5	-
44	29-Nov4	30.4	23.0	90	003.0	-
45	5-11	30.8	23.1	91	002.8	-
46	12-18	29.6	23.2	85	002.0	-
47	19-25	28.1	23.0	83	274.4	10
48	26-Dec2	27.3	23.2	96	302.6	12
49	3-9	29.8	23.2	94	050.0	2
50	10-16	28.2	22.7	89	120.2	4
51	17-23	28.7	21.8	93	001.0	-
52	24-31	29.0	23.7	87	005.6	-

Growth Parameters

Among the treatments, application of 100 per cent recommended N (T_1 120 kg ha^{-1}) registered the highest values in the growth components such as plant height, number of primary branches, secondary branches at 60, 90 and harvest stages respectively and dry matter production was recorded at harvest.

Flowering

Among the treatments, application of 100 per cent recommended N (T_1 120 kg ha^{-1}) recorded fifty per cent flowering in 65.53 days. Organic manures application treatment (T_0) took 67.93 days to 50 per cent flowering.

Yield Parameters

The yield components viz., number of pods $plant^{-1}$, number of seeds pod^{-1} and hundred seed weight were higher when soil application of 100 per cent recommended N (T_1) produced the higher number of pods $plant^{-1}$, seeds pod^{-1} and hundred seed weight. Use of inorganic nitrogen 100 per cent created excellent performance in terms of yield components.

Seed and Tuber Yield

Among the treatments, application of 100 per cent recommended N (T_1) produced the higher seed yield. Similar trend was recorded in case of tuber yield.

Nutrient Uptake

The uptake of nutrients (NPK) was significantly increased by basal application Among the N levels, application of 100 per cent recommended N (T_1) had a significant effect on NPK uptake, while the least was recorded under control (T_0).

Economics

100 per cent recommended N (T_1) recorded the highest return $rupee^{-1}$ invested of Rs. 4.62 while the least return $rupee^{-1}$ invested of Rs. 3.96 was observed in the treatment organic manure application (T_0).

Conclusion

Based on the above results, it can be concluded that inorganic use of 100 per cent recommended N (120 kg ha^{-1}) is found to be an appropriate agro-technique for augmenting the productivity and profitability of glori lily without altering the soil fertility. It is a basic constituent in all proteins, enzymes, chlorophyll, certain parts of nucleus and hormone. The supply of nitrogen is related to carbohydrates utilization for growth and development process.

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R_1	R_2	R_3	R_4
T_1	T_2	T_5	T_3
T_2	T_5	T_4	T_1
T_3	T_4	T_2	T_4
T_4	T_3	T_1	T_5
T_5	T_1	T_3	T_2

FIG.1 LAYOUT OF THE EXPERIMENTAL FIELD

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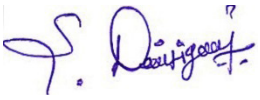

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