Integrated Nutrient Management on the yield and nutrition of Medicinal Glory Lily (*Gloriosa superba L.*) in a Coastal soil

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Abstract:- The productivity of crops in coastal soils are low owing to salinity, poor organic matter, nutrient availability, leaching, etc, Alternate land use involving the cultivation of medicinal plants has a greater scope of improving farm income due to increasing demand and export potential. One field experiment was carried out in a farmer's field in coastal sandy soil which was analyzed for pH 6.74 and EC 1.52 dS m^{-1}. The soil had an organic carbon content of 0.32 percent and available nutrient status was low in N and medium in P and K. The treatments evaluated were T_1 – Absolute Control, T_2 – Recommended NPK, T_3 – FYM alone @ 12.5 t ha^{-1} , T_4 – Humic acid alone @ 20.0 t ha^{-1}, T_5 – 75 % NPK + FYM @ 12.5 t ha^{-1}, T_6 - 75 % NPK + Humic acid @ 20.0 kg ha^{-1}, T_7 - 50 % NPK + FYM @ 12.5 t ha^{-1}, T_8 – 50 % NPK + Humic acid @ 20.0 kg ha^{-1}, T_9 – T_5 + $ZnSO_4$ @ 25 kg ha^{-1} + Panchakavya foliar spray, T_{10} – T_6 + $ZnSO_4$ @ 25 kg ha^{-1} + Panchakavya foliar spray , T_{11} – T_7 + $ZnSO_4$ @ 25 kg ha^{-1} + panchakavya foliar spray and T_{12} – T_8 + $ZnSO_4$ @ 25 kg ha^{-1} + Panchakavya foliar spray. The experiment was carried out in Randomised Block Design with three replications. The medicinal plant Gloriosa superba was grown as a test crop. The results of the field experiment indicated the beneficial effect of INM treatments in increasing the growth and yield of Glory lily. Among various treatments evaluated, T_{10}- 75 percent NPK + $ZnSO_4$ @ 25 kg ha^{-1} + Humic acid 20 kg ha^{-1} + Panchakavya foliar spray accounted for higher plant height (148.5), number of branches (5.32), number of pods per plant (179) and seed yield (21.24 g $plant^{-1}$). This treatment also significantly increased the major nutrient N, P, and K content in haulm and seed of Glory lily.

Key Words:- Integrated Nutrient Management, Medicinal Glory lily, yield and nutrition, coastal soil
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1 Introduction

The coastal areas, mostly salt affected characterized by low organic matter, CEC, and available plant nutrients [22], [5]. Total salt-affected soils in the world extend up to 932.2 million ha [1] and the area under salt-affected in South Asia is around 52 million ha [10]. Around the world, 85 percent area is slightly to moderately affected and around 15 percent of the area suffers from severe to extreme limitations for crop cultivation [24]. Soil salinization reduces the net cultivable area of any country. It reduces the agricultural productivity and quality of crops being produced. Under salt stress, the average yield reduction of most of the crops was around 20 and 50 percent [18]. Globally attention is now being given to developing non-conventional crops for salt-affected and water-logged situations. Growing alternative crops that are nontraditional such as medicinal plants has the advantage of meeting our increasing demand and export potential. As per the WHO, 80 percent of the population in developing countries relies on traditional natural medicine. India exports herbal products and medicines to the tune of Rs.550 crores annually [8]. A survey indicated that the use of herbal medicine will reach the tune of US $ 5 trillion by 2050. Glory lily (*Gloriosa superba L.*) is a medicinal plant belonging to the family Liliaceae is a semi-woody herbaceous branched climber reaching approximately 5 meters in height, with brilliant wavy-edged yellow and red flowers. The plant especially the tubers and seeds contain alkaloids such as Colchicines and Gloriosine [20]. The colchicine content varies from 0.15 to 0.3% in the rhizomes and

0.7 % to 0.9% in the seeds. The tuber is used traditionally for the treatment of bruises and sprains, colic, chronic ulcers, hemorrhoids, cancer, impotence, nocturnal seminal emission, and leprosy, for inducing labor pains and abortions [9].The major landmark for the cultivation of medicinal plants is the lack of a standard cultivation package, particularly nutrient management. The emphasis on Integrated Nutrient Management (INM) practice in medicinal plant production is highly relevant because of the improved quality of crop produce coupled with a higher yield. INM entails the maintenance of soil fertility to an optimum level for crop productivity to obtain the maximum benefit from all possible sources of plant nutrients organics as well as organics in an integrated manner [3].

2 Materials and Methods

A field experiment was carried out in a farmer's field near Chidambaram (11·36'N latitude and 11·36' E longitude) in coastal sandy soil. The soil characterized a pH of 6.74 and EC 1.52 dS m^{-1}. The soil had an organic carbon content of 0.32 percent and the status of available nutrients was low in N, medium in P, and K status. The treatments were T_1 – Absolute Control, T_2 – Recommended NPK, T_3 – Farm Yard manure (FYM) alone @ 12.5 t ha^{-1} , T_4 – Humic acid alone @ 20.0 t ha^{-1}, T_5 – 75 % NPK + FYM @ 12.5 t ha^{-1}, T_6 - 75 % NPK + Humic acid @ 20.0 kg ha^{-1}, T_7 - 50 % NPK + FYM @ 12.5 t ha^{-1}, T_8 – 50 % NPK + Humic acid @ 20.0 kg ha^{-1}, T_9 – T_5 + $ZnSO_4$ @ 25 kg ha^{-1} + Panchakavya foliar spray, T_{10} – T_6 + $ZnSO_4$ @ 25 kg ha^{-1} + Panchakavya foliar spray , T_{11} – T_7 + $ZnSO_4$ @ 25 kg ha^{-1} + panchakavya foliar spray and T_{12} – T_8 + $ZnSO_4$ @ 25 kg ha^{-1} + Panchakavya foliar spray. Bio inoculants Azospirillum and Phosphobacteria @ 2 kg per ha^{-1} (a lignite-based culture which contains $2x10^8$ CFU/ g living cell) were applied to all the plots excluding absolute control (T_1) and recommended NPK (T_2). The experimental design was Randomised Block Design with three replications. The medicinal plant *Gloriosa superba* was grown as a test crop. Various growth and yield characteristics were recorded during crop growth. At the harvest plant and seed, samples were collected from each treatment. The plant samples were washed in distilled water and dried in a hot air oven at 80· C. The plant and seed samples were digested in di acid (H_2SO_4: $HClO_4$ acid; 4:1 ratio) and estimated for the contents of N, P, and K using the procedure as outlined by [6].

3 Results and Discussion

3.1 Growth and yield

The results of the study indicated the efficacious role played by the various INM treatments in significantly increasing the growth character of Glory lily (Table 1). The absolute control, without the addition of any fertilizer and organic manure, recorded the lowest plant height (82.6 cm) and the number of branches (1.71). Various INM treatments increased the plant height to a range of 127.9 to 148.5 cm and the number of branches to 4.06 - 5.32. Among the treatments, application of 75 % NPK fertilizer + $ZnSO_4$ @ 25 kg ha^{-1} + Humic acid @ 20 kg ha^{-1} + Panchakavya foliar spray ranked best in recording the highest plant height (148.5 cm and no. of branches (5.72). This was followed by T_9, 75 % NPK + $ZnSO_4$ + FYM + Panchakavya foliar spray. Balanced nutrition on account of the application of FYM and humic acid along with inorganic fertilizers facilitated better cell division and enlargement which increased higher plant height. This was in accordance with the earlier findings of [12]. The treatment T_{10} registered the highest leaf number of 179 per plant followed by the T_9 treatment (168). The increase in growth characteristics of Glory lily might be due to NPK fertilizers with organic manures and biofertilizers promoting luxuriant growth as influenced by the increased supply of nutrients to the crop. The increased growth of medicinal plants with Integrated Nutrient Management including panchakavya application has already been reported [11], [7]. Further, humic acid also played a significant role in increasing growth parameters might be due to the growth-promoting action and presence of gibberellins-like substances in humic acid [17, 21].

Table 1. Integrated Nutrient Management on the growth and yield of Glory Lily

Treatments	Plant height (cm)	No. of branches/ pl.	No. of leaves/ pl.	No. of pods/pl.	Seed yield plant^{-1} (g)	Seed yield (kg ha^{-1})
T_1	82.6	1.71	91	4.97	11.73	237
T_2	118.7	3.43	138	8.89	15.30	309
T_3	105.3	3.16	117	7.15	13.37	270
T_4	110.4	3.28	126	7.56	13.91	281
T_5	127.9	4.06	157	12.33	17.77	359
T_6	135.6	4.25	166	14.86	18.22	368
T_7	117.5	3.87	145	9.53	15.97	322
T_8	120.3	3.93	150	10.67	16.38	331
T_9	141.7	4.94	168	16.15	19.70	398
T_{10}	148.5	5.32	179	18.62	21.24	429
T_{11}	118.2	4.26	149	10.89	16.93	342
T_{12}	125.6	4.57	156	13.14	18.02	364
S.Ed	3.11	0.10	4.15	0.31	0.36	14
CD (p=0.05)	6.20	0.21	8.32	0.62	0.73	28

T_1 – Absolute Control, T_2 – Recommended NPK, T_3 – FYM alone @ 12.5 t ha^{-1} , T_4 – Humic acid alone @ 20.0 t ha^{-1}, T_5 – 75 % NPK + FYM @ 12.5 t ha^{-1}, T_6 - 75 % NPK + Humic acid @ 20.0 kg ha^{-1}, T_7 - 50 % NPK + FYM @ 12.5 t ha^{-1}, T_8 – 50 % NPK + Humic acid @ 20.0 kg ha^{-1}, T_9 – T_5 + $ZnSO_4$ @ 25 kg ha^{-1} + Panchakavya foliar spray, T_{10} – T_6 + $ZnSO_4$ @ 25 kg ha^{-1} + Panchakavya foliar spray , T_{11} – T_7 + $ZnSO_4$ @ 25 kg ha^{-1} + panchakavya foliar spray and T_{12} – T_8 + $ZnSO_4$ @ 25 kg ha^{-1} + Panchakavya foliar spray.

Table 2. Integrated Nutrient Management on the nutrient content of Glory Lily

Treatments	Haulm (%)			Seed (%)		
	N	P	K	N	P	K
T_1	0.98	0.23	1.13	1.02	0.15	0.62
T_2	1.31	0.29	1.35	1.35	0.18	0.68
T_3	1.18	0.26	1.21	1.20	0.19	0.69
T_4	1.23	0.27	1.25	1.27	0.20	0.72
T_5	1.33	0.32	1.48	1.38	0.21	0.79

T_6	1.37	0.33	1.52	1.43	0.24	0.83
T_7	1.32	0.29	1.39	1.36	0.21	0.78
T_8	1.35	0.31	1.44	1.40	0.23	0.79
T_9	1.52	0.35	1.60	1.60	0.25	0.98
T_{10}	1.61	0.39	1.69	1.72	0.28	1.05
T_{11}	1.43	0.32	1.48	1.46	0.22	0.88
T_{12}	1.47	0.33	1.52	1.52	0.24	0.92
S.Ed	0.02	0.01	0.04	0.01	0.007	0.02
CD(p=0.05)	0.04	0.02	0.08	0.02	0.015	0.05

Application of INM treatments significantly enhanced the pod number and seed yield of Glory lily. While recommended NPK recorded 8.89 pods per plant and seed yield of 237 kg ha^{-1}, the treatment T_{10}, application of 75 % NPK fertilizer + $ZnSO_4$ + Humic acid + Panchakavya foliar spray registered a significantly higher number of pods per plant (18.62) and seed yield (429 kg ha^{-1}). A seed yield of 309 kg ha^{-1} was recorded in recommended NPK. The increase in seed yield recorded with T_{10} treatment was 81.01 and 38.83 percent increase over absolute control (T_1) and recommended NPK (T_2) respectively. The other treatments ie., application of organic manures alone and along with $ZnSO_4$ also significantly increased the seed yield of Glory lily over absolute control. Panchakavya application increased the growth and yield through the activity of beneficial microbes coupled with growth-promoting activity by the presence of substances like kinetin (cytokinin) and auxin which promoted cell division and cell enhancement [23]. For performing the necessary physiological function to build up different yield attributes these nutrients, inorganic, organic, and biofertilizers including growth-promoting substances have been integrated with the present study. They were possibly responsible for synthesizing necessary enzymes, proteins, energy (ATP and NADP), chlorophyll, and others for translocation of photosynthates resulting in higher yield. These findings were supported by [7, 13, 14]. The improved growth and development of root and shoot on account of a balanced and timely supply of nutrients needed by crops have led to better partitioning of photosynthate from source to sink with INM treatment. This finding corroborated the earlier reports by [4],[19].

3.2 Nutrient content

All the INM treatments evaluated exhibited their beneficial influence in increasing the N, P, and K content of glory lily (Table 2). While, control recorded the lowest N content of 0.98 percent (haulm) and 1.02 percent (seed), the INM treatment T_{10}, 75 % NPK + humic acid @ 20 kg ha^{-1} + $ZnSO_4$@ 25 kg ha^{-1} + panchakavya foliar spray recorded the highest N content of 1.61 and 1.72 percent in haulm and seed respectively. The other INM treatments also increased the N content to the range of 1.33 to 1.52 percent in haulm and 1.38 – 1.60 percent in the seed. Higher N content due to NPK nutrient with organic manure and biofertilizers was earlier reported by [15]. The availability of P in coastal soil is restricted due to salinity and pH. With the application of INM, there was a significant increase in the content of P by glory lily. The treatment, 75 % NPK along with organic and Zn recorded a P content of 0.32 and 0.28 percent in haulm and seed respectively. This was followed by T_9 treatment. The lowest phosphorus content was recorded in the control (0.23 and 0.15 percent). Earlier, [14] also recorded higher P content in medicinal crops with the integrated nutrient application. Among the various treatments, the highest K content was recorded in T_{10} followed by T_9 and T_{12}. The treatment T_{10}, 75

% NPK + humic acid + $ZnSO_4$, and panchakavya foliar spray recorded a significantly higher K content of 2.69 percent in haulm and 1.05 percent in the seed. The increase in N, P, and K content of Gloria Superba might be due to the adequate supply of macro and micronutrients under Integrated Nutrient Management. The organic manures and humic acid served as a source of plant nutrients and humus, which improved the soil physical condition by increasing its capacity to absorb and store water and nutrients, improving aeration and favoring microbial activity, thereby improving conditions favorable for nutrient uptake. The earlier work by [16], [4] supports the present findings. Further, it may also be due to the addition of inorganic and organic nutrients, the bioregulator panchakavya contained major and micronutrients and growth hormones like GA and auxins which promoted the uptake of nutrients [13].

4 Conclusion

It has been concluded from the present study that INM practice holds promise in increasing the growth, yield, and nutrition of Glory lily in coastal sandy soil. The integrated application of 75 percent recommended dose of NPK fertilizer along with soil application of $ZnSO_4$ @ 25 kg ha^{-1} + Humic acid @ 20 kg ha^{-1} and foliar application of Panchakavya proved most efficient among treatments in increasing all the growth characters, yield and nutrient content of Glory lily grown under sandy soils.

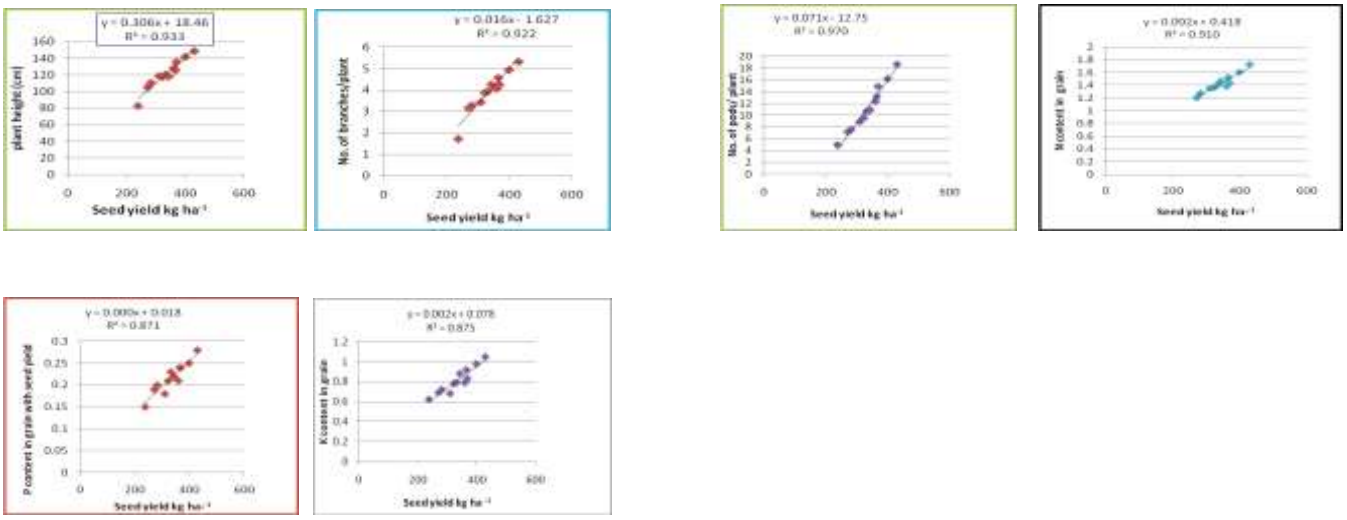

Fig 1. Correlation of plant character and nutrient content with seed yield

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