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Optimizing nutrient sources for quality bulb and bulblet production in LA hybrid lilium: A study in the North Indian plains

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Abstract

LA hybrid lilium cv. 'Masai' bulbs were grown over two consecutive growth seasons in a net house to enhance the yield of high-quality bulbs and bulblets, utilizing both organic and inorganic nutrients. The experiment tested five levels of organic manure (FYM) (0, 10, 15, 20, and 25 t ha^{-1}) and inorganic fertilizers (0, 40+30+25, 80+60+50, 120+90+75, and 160+120+100 $N+P_2O_5+K_2O$ kg ha^{-1}). It assessed both individual and combined effects of nutrient sources, concluding that their combined application was most beneficial. Treatment T_{24}, comprising 25 t FYM with 160 kg N, 120 kg P_2O_5, and 100 kg K_2O ha^{-1}, proved to be the most effective. The study revealed that treatment T_{24} resulted in the largest bulb circumference, the highest number of bulblets per plant, the greatest bulblet circumference, and the highest fresh and dry weights of both bulbs and bulblets per plant. It also led to the best relative growth rate (RGR) of the bulb, as well as the most efficient partitioning rates at both the flowering and harvest stages. Treatment T_{23} notably influenced the fresh and dry weights of the bulblets. The data suggest that T_{24} produces bulbs and bulblets of superior quality compared to other treatments, making it a viable choice for the commercial cultivation of quality LA hybrid lilium bulbs and bulblets in the plains of India.

Key words: LA hybrid lilium (*Lilim longiflorum*× *Lilium asiatica*), cultivar 'Masai', RGR, partitioning rate, bulb and bulblets, fresh weight and dry weight.

Introduction

Lilium (*Lilium* spp.) is a significant bulbous ornamental plant within the Liliaceae family. It ranks among the top ten cut flowers globally due to its impressive size, elegance, and longevity. Lilium typically produces large and often fragrant blossoms in hues of white, yellow, orange, pink, red, and purple (Pooja and Suchismita, 2020). This species has considerable economic importance in the cut flower production and marketing sectors of the worldwide floral market (Jimenez *et al.,* 2012). The lily market has recently seen rapid expansion as consumer preferences for these flowers grow steadily.

Lilium is versatile for planting in borders, beds, pots, and it serves as exceptional cut flower known for its striking looks and vibrant colors (Swetha *et al.,* 2018). The global market is dominated by three primary lilium groups: Asiatic hybrids, Oriental hybrids, and LA hybrids. LA hybrids are increasingly preferred over Asiatic hybrids (Diksha *et al.,* 2023), characterized by their larger size and flowers that face upwards. In the floral industry, LA hybrid lilies are widely utilized as cut flowers and pot plants.

Most bulbs are sourced from the Netherlands and are cultivated in unheated plastic or net houses for the autumn crop, under shade nets, or in open fields during the summer. The demand for lily bulbs escalates annually. Regrettably, there is no domestic source for high-quality bulbs for cut flower cultivation in India. In the last three to four years, imported bulbs have surged from INR 10 to INR 20, compounded by the fluctuating euro to rupee exchange rate, further escalating import costs (Muneeb *et al.,* 2016). Therefore, it is imperative to promote the production of lily bulbs and bulblets using the latest local production technologies.

The nutrient supply significantly influences bulbs and bulblets' growth, flowering, and production in ornamental bulbous crops. High-quality bulbs and bulblets are crucial for competitiveness in both domestic and export markets. With global soil quality in decline, long-term crops can no longer rely solely on natural resources. Therefore, providing appropriate nutrients is vital for cultivating high-quality flowers, bulbs, and bulblets. For instance, the yield of high-quality bulbs and bulblets in lilium depends on the applied nutrients. Conducting plant nutrition research on bulbous flowers is often difficult because the bulbs store the necessary nutrients. While Lilium species do not require high levels of nutrition, adequate nourishment is essential for producing high-quality bulbs and bulblets.

The primary focus wass on standardizing fertilizer use, particularly nitrogen, to produce high-quality bulbs (Muneeb *et al.,* 2016). Organic fertilizers are preferred as they are composed of natural materials that are environmentally benign (Moghadam *et al.,* 2012). Well-decomposed farmyard manure (FYM) is rich in macro- and micronutrients, sustaining soil quality, enhancing plant health, and producing quality harvest. Likewise, an adequate supply of nutrients like nitrogen, phosphorus, and potassium is crucial for the growth and yield of quality bulbs and bulblets in lilium. In contrast, the traditional lily cultivation method, characterized by random fertilizer application, does not assure cultivation benefits and is unsuitable for commercial purposes.

The study aimed to explore the impact of organic (FYM) and inorganic fertilizers and their combined use to determine the ideal nutrient dosage for producing high-quality bulbs and bulblets of LA hybrid lilium in the North Indian plains. The primary objective was to guide farmers and producers for a more scientific approach to fertilizer application, thereby enhancing the quality and production efficiency of LA hybrid lilium bulbs and bulblets in controlled environments.

Materials and methods

Experimental material: uniformly-sized, high-quality bulbs of the lilium variety 'Masai', measuring 14-16 cm in diameter, were utilized for the study. This variety reaches 100 to 120 cm height and bears orange-colored flowers.

The experimental site and design: The study was conducted at the Floriculture Research Farm of the ICAR-Indian Agricultural Research Institute, New Delhi, India, located at 28°35' N latitude, 77°12' E longitude, and an elevation of 228.16 meters above sea level. The experimental design was a factorial randomized block design (FRBD) consisting of 25 treatment combinations, each replicated thrice.

Treatment details: As outlined in Table 1, the experiment involved two variables: five levels of organic manure in the form of Farmyard Manure (FYM) and five levels of inorganic fertilizers (N), specifically nitrogen as urea, phosphorous as single superphosphate (SSP), and potassium as muriate of potash (MOP). The interactions between these two variables were also assessed.

Fertilizer application: The soil was excavated to a depth of at least 30 cm, thoroughly mixed with well-decomposed farmyard manure (FYM) as per the treatment requirements, and left to rest for a month. Single Super Phosphate (SSP) and Muriate of Potash (MOP) were applied in full as a basal dose when bulb planting. Urea was administered in three equal split doses at intervals of 30, 60, and 75 days after planting.

Bulb planting: raised beds of 25 cm height and one-meter width were constructed, with a 40-cm-wide path in the center. The bulbs were pre-treated with Bavistin at a concentration of 0.2% before planting. Planting was carried out with a spacing of 20×20 cm and at a depth of 12 cm, under a 50% shade net (Fig. 1). Typically, bulbs are planted at a depth three times their diameter. After planting, the bulbs were lightly watered, causing the soil to settle by 3 to 4 cm, leaving a covering of 5 to 8 cm above each bulb. This depth is crucial for proper stem root growth. Shallow planting can result in inadequate stem-root development, adversely affecting the quality of the bulbs and bulblets.

Intercultural operations

Weeding: Three to four sessions of hand weeding were conducted.

Staking: As the crop grows taller, the branches cannot support the weight of the large, heavy flower heads. Nylon rope was utilized for support in such cases.

Irrigation: Initially, the plants were watered using a water can for the first two weeks. Starting in the third week, the beds were subjected to flood irrigation once every week.

Pests and diseases: Aphid and thrips infestation were observed during the bud initiation stage. These were managed by applying Malathion at a concentration of 2 mL/L every 8 to 10 days. Botrytis blight (*Botrytis elliptica*) and other diseases were monitored and addressed with weekly foliar applications of Bavistin and Dithane M-45, each at a concentration of 2 g/L.

Bulb and bulblet sampling: Samples of bulbs and bulblets from five randomly selected plants were collected at specified intervals, specifically at the flowering stage (80 days after planting) and the bulb harvesting stage (110 days after planting). The plants were entirely uprooted, cleaned, and subjected to analyses of various parameter.

Table 1. Details of different treatments used in the present study on LA hybrid Lilium cv. 'Masai'

Treatment	Treatment details
T_1	10 t FYM ha^-
T_2	15 t FYM ha^{-1}
T_3	20 t FYM ha^{-1}
T_4	25 t FYM $h^{a-}1$
T_5	40:30:25 kg N: P_2O_5: K_2O h^{a-1}
T_6	80:60:50 kg N: P_2O_5: K_2O ha^{-1}
T_7	120:90:75 kg N: P_2O_5: K_2O ha^{-1}
T_8	160:120:100 kg N: P_2O_5: K_2O ha^{-1}
T_9	10 t FYM + 40:30:25 kg N: P_2O_5: K_2O ha^{-1}
T_{10}	10 t FYM+80:60:50 kg N: P_2O_5: K_2O ha^{-1}
T_{11}	10 t FYM+120:90:75 kg N: P_2O_5: K_2O ha^{-1}
T_{12}	10 t FYM+160:120:100 kg N: P_2O_5: K_2O ha^{-1}
T_{13}	15 t FYM+ 40:30:25 kg N: P_2O_5: K_2O ha^{-1}
T_{14}	15 t FYM+80:60:50 kg N: P_2O_5: K_2O ha^{-1}
T_{15}	15 t FYM+120:90:75 kg N: P_2O_5: K_2O ha^{-1}
T_{16}	15 t FYM+160:120:100 kg N: P_2O_5: K_2O ha^{-1}
T_{17}	20 t FYM+ 40:30:25 kg N: P_2O_5: K_2O ha^{-1}
T_{18}	20 t FYM+80:60:50 kg N: P_2O_5: K_2O ha^{-1}
T_{19}	20 t FYM+120:90:75 kg N: P_2O_5: K_2O ha^{-1}
T_{20}	20 t FYM+160:120:100 kg N: P_2O_5: K_2O ha^{-1}
T_{21}	25 t FYM+ 40:30:25 kg N: P_2O_5: K_2O ha^{-1}
T_{22}	25 t FYM+80:60:50 kg N: P_2O_5: K_2O ha^{-1}
T_{23}	25 t FYM+120:90:75 kg N: P_2O_5: K_2O ha^{-1}
T_{24}	25 t FYM+160:120:100 kg N: P_2O_5: K_2O ha^{-1}
T_{25}	Control

Fig. 1. Experiment view at early growth stage

Relative Growth Rate (RGR): To determine the RGR of bulbs from the flowering to the bulb harvesting stage, the shoot was detached from the bulbs. The bulbs from each plant were then placed in brown paper bags and dried in a hot air oven. After drying, the final dry weight was noted. The RGR of the bulbs was calculated using Radford's equation (1967) as follows:

$$RGR\ (mg\ g^{-1}\ day^{-1}) = \frac{\log W2 - \log W1}{t2 - t1}$$

Where W1 and W2 are the dry weight of the bulb at flowering time t1 and bulb harvesting time t2, respectively.

Partitioning rate: The dry matter accumulation and photosynthetic partitioning between shoots and bulbs was evaluated. To determine the partitioning rate, the entire plant was divided into shoots, bulb and bulblets, and roots. Each plant section was placed in brown paper bags and dried in a hot air oven. After recording the final dry weight, the partitioning rate was calculated using the formula below.

$$\text{Partitioning ratio} = \frac{Bw}{Sw + Bw + Rw}$$

Where Bw, Sw, and Rw are bulb and bulblets dry weight, shoot dry weight, and root dry weight, respectively.

Bulb and bulblet parameters: Following the harvest, the total number of bulblets per plant was counted, and the fresh and dry weights (g) of both bulbs and bulblets were recorded. Additionally, the circumference of the bulbs and bulblets was measured using a digital Vernier calliper (cm).

Statistical analysis: The experimental data was analyzed using the Analysis of Variance (ANOVA) technique, utilizing Excel and the SPSS package for estimating the mean, standard error, and critical difference. The critical difference method was employed to compare the means of the treatments, with results being tested for significance at the five percent level for each characteristic.

Results and discussion

Bulb and bulblet characteristics: Tables 2 and 3 present the impact of organic manure and inorganic fertilizers on the bulb and bulblet traits of LA hybrid lilium cv. 'Masai'. Significant variations in these characteristics were observed following the application of both organic and inorganic nutritional sources. Among the soil treatments with different FYM concentrations, T_4 showed the highest measurements in bulb circumference (10.08 cm), fresh bulb weight (27.33 g), dry bulb weight (7.89 g), number of bulblets (2.90), bulblet circumference (3.02 cm), fresh weight of bulblets per plant (4.00 g), dry weight of bulblets per plant (0.51 g), combined fresh weight of bulbs and bulblets per plant (31.33 g), and combined dry weight of bulbs and bulblets per plant (8.40 g). In contrast, treatment T_1 exhibited the lowest values in these categories. The study indicated significant growth in bulbs and bulblets with increased FYM levels. Using organic fertilizers in soil can greatly improve plant growth and ensure a continuous supply of macro- and micronutrients (Sahni *et al.,* 2008). Our findings are consistent with the root length and dry mass of the Eastern lily, which reached 2.5 g with the application of organic fertilizer, particularly poultry manure (Mahboubeh *et al.,* 2013). Naznin *et al.* (2015) observed similar outcomes in tuberose and Thakur *et al.* (2023) in gladiolus.

Among various inorganic fertilizer concentrations, plants treated with T_8 showed the highest bulb circumference (9.10 cm), fresh bulb weight (21.23 g), dry bulb weight (4.09 g), number of bulblets (1.93), bulblet circumference (2.38 cm), fresh weight of bulblets per plant (3.52 g), dry weight of bulblets per plant (0.37 g), combined fresh weight of bulb and bulblets per plant (24.75 g), and combined dry weight of bulb and bulblets per plant (4.46 g). In contrast, treatment T_5 had the lowest values (refer to Tables 2 and 3). An increase in fertilizer application correlated with improved bulb and bulblet characteristics, possibly due to enhanced nutrient availability, particularly nitrogen, which significantly affects lilium growth and bulb production. These findings align with those of Sheoran *et al.* (2015), who found that higher nitrogen fertilizer doses improved bulb characteristics in tuberose, including diameter and weight. Vedavathi *et al.* (2014) observed that higher NPK fertilizer doses resulted in a greater number of bulblets per plant in Asiatic lily, attributed to faster growth and increased metabolite production. Similarly, higher inorganic fertilizer doses in the Asian lily 'Tresor' led to greater bulb weight, likely due to optimal nitrogen facilitating the transfer of photosynthetic material from leaves to bulbs, culminating in maximum bulb weight (Swetha *et al.,* 2018). Comparable outcomes were noted in tulip (Khan *et al.,* 2006) and tuberose (Sendhilnathan and Manivannan, 2019; Sujatha *et al.,* 2000).

The interaction effects revealed significant differences in bulb and bulblet traits. According to the data in Tables 2 and 3, among the various treatment combinations, T_{24} showed the highest bulb circumference (11.23 cm), fresh bulb weight (30.50 g), dry bulb weight (12.00 g), number of bulblets (3.33), bulblet circumference (3.13 cm), fresh weight of both bulb and bulblets per plant (35.51 g), and dry weight of both bulb and bulblets per plant (12.80 g). In contrast, T_{23} significantly affected the fresh weight of bulblets per plant (5.01 g) and the dry weight of bulblets per plant (0.80 g). The control treatment, however, recorded the lowest bulb circumference (9.00 cm), fresh bulb weight (20.20 g), dry bulb weight (2.50 g), number of bulblets (1.90), bulblet circumference (2.16 cm), fresh weight of bulblets per plant (0.90 g), dry weight of bulblets per plant (0.20 g), fresh weight of both bulb and bulblets per plant (21.10 g), and dry weight of both

Table 2. Influence of organic manure and inorganic fertilizers on bulb and bulblet characteristics of LA hybrid lilium cv. 'Masai'

Treatments	Bulb circumference (cm)	Fresh weight of bulb (g)	Dry weight of bulb (g)	Number of bulblets/ plant	Bulblet circumference (cm)
Organic manure (F)					
T_1	9.12	21.25	3.15	1.94	2.40
T_2	9.30	22.30	4.10	2.01	2.48
T_3	10.00	25.50	6.24	2.31	2.68
T_4	10.08	27.33	7.89	2.90	3.02
SE (m) ±	0.13	0.39	0.95	0.15	0.12
CD (*P*=0.05)	0.002	0.02	0.02	0.03	0.002
Inorganic fertilizer (N)					
T_5	9.05	20.23	3.00	1.91	2.30
T_6	9.08	20.36	3.10	1.92	2.32
T_7	9.08	20.73	3.10	1.92	2.35
T_8	9.10	21.23	4.09	1.93	2.38
SE (m) ±	0.13	0.39	0.10	0.15	0.12
CD (*P*=0.05)	0.002	0.02	0.05	0.03	0.002
Interaction (F*N)					
T_9	9.18	21.28	4.20	1.95	2.41
T_{10}	9.19	21.35	4.62	1.97	2.43
T_{11}	9.20	22.00	4.90	1.98	2.45
T_{12}	9.22	22.22	4.99	2.00	2.48
T_{13}	9.38	22.30	4.90	2.05	2.49
T_{14}	9.48	23.50	5.32	2.09	2.49
T_{15}	9.50	24.66	6.34	2.20	2.50
T_{16}	9.55	25.26	7.59	2.28	2.52
T_{17}	10.01	25.62	7.92	2.35	2.71
T_{18}	10.05	25.89	7.92	2.48	2.75
T_{19}	10.06	26.00	8.09	2.50	2.89
T_{20}	10.07	26.20	8.77	2.58	2.92
T_{21}	10.13	27.60	9.31	3.00	2.77
T_{22}	10.20	28.00	10.34	3.20	3.10
T_{23}	11.21	29.00	11.18	3.31	3.12
T_{24}	11.23	30.50	12.00	3.33	3.13
T_{25}	9.00	20.20	2.50	1.90	2.16
SE (m) ±	0.29	0.88	0.82	0.35	0.27
CD (*P*=0.05)	0.01	0.09	0.09	0.01	0.009

bulb and bulblets per plant (2.75 g). This may be attributed to the synergistic effects of farmyard manure (FYM) with inorganic fertilizers. FYM, being rich in carbon, likely enhances bulb and bulblet growth in optimal treatments by acting as a slow-releasing nutrient source and boosting soil microbial activity. Seyedeh *et al.* (2015) noted that organic and mineral nutrition, especially during growth, is vital for Easter lily bulb development. These findings align with the observation that a combination of 50% farmyard manure (15.2 t FYM ha^{-1}) and 50% recommended dose of fertilizers (75:50:40 NPK kg ha^{-1}) significantly influences the yield and quality of bulb and bulblet in Asiatic lilies (Lokeshwar *et al.,* 2017). Similar results have been reported for Glory Lily (Gupta *et al.,* 2013), tuberose (Habib *et al.,* 2016; Jamja *et al.,* 2024), and gladiolus (Akter *et al.,* 2017; Dhakar *et al.,* 2020).

Relative growth rate and partitioning rate: Significant variations in dry matter accumulation was recorded during the flowering and harvesting stages, as indicated by the bulb's relative growth rate (RGR) and partitioning rate, based on different levels of organic amendment and inorganic fertilizer (Table 4). Among the various doses of FYM, the highest bulb RGR (21.04 mg g^{-1} day^{-1}), partitioning ratio at flowering (0.18), and partitioning ratio at harvesting (0.51) were observed in treatment T_4, followed by treatments T_3 and T_2. The increased accumulation of photosynthates was linked to higher levels of FYM, possibly due to enhancement of chemical and physical properties soil by organic manure. FYM being crucial for nutrient availability, photosynthate accumulation, and the export of more photosynthates to bulbs, as evidenced by increased photosynthate partitioning, bulb mass, and bulb RGR. This is supported by Muneeb *et al.* (2016) in their study on Asiatic Lily.

Among the different levels of inorganic fertilizers, treatment T_8 led to a higher bulb relative growth rate (RGR) of 20.09 mg g^{-1} day^{-1}, a partitioning ratio at flowering of 0.20, and a partitioning ratio at harvesting of 0.45, surpassing T_7 (Table 4). This could be attributed to the fact that an increased availability of nutrients enhances photosynthesis and facilitates the transfer of excess photosynthates to the subterranean bulb parts. The minerals present in organic fertilizers, such as potassium, phosphorus, and nitrogen, are accessible for both plants and soil microbes to absorb. These elements are crucial for plants' biological and physiological functions, including forming cellular membranes and cell division, as noted by Alsaleh and Awadh (2020). The role of nitrogen in augmenting the amount of assimilates necessary for improving the partitioning of photosynthates in plants was highlighted by Sheoran *et al.* (2015). An increased uptake of NO_3 has been associated with a rise in the accumulation of dry matter

Table 3. Influence of organic manure and inorganic fertilizers on bulb and bulblet characteristics of LA hybrid lilium cv. 'Masai', continued

Treatments	Fresh weight of bulblets per plant (g)	Dry weight of Bulblets per plant (g)	Fresh weight of both bulb and bulblets per plant (g)	Dry weight of both bulb and bulblets per plant (g)
Organic manure (F)				
T_1	3.11	0.45	24.36	3.60
T_2	3.20	0.48	25.50	4.58
T_3	3.20	0..48	28.70	6.72
T_4	4.00	0.51	31.33	8.40
SE (m) ±	0.08	0.05	0.06	0.05
CD (*P*=0.05)	0.0007	0.006	0.005	0.002
Inorganic fertilizer (N)				
T_5	2.86	0.30	23.09	3.30
T_6	2.90	0.32	23.26	3.42
T_7	3.44	0.35	24.17	3.45
T_8	3.52	0.37	24.75	4.46
SE (m) ±	0.08	0.05	0.06	0.06
CD (*P*=0.05)	0.0007	0.005	0.02	0.002
Interaction (F*N)				
T_9	4.09	0.40	25.37	4.60
T_{10}	4.17	0.43	25.52	5.05
T_{11}	4.29	0.44	26.29	5.34
T_{12}	3.51	0.37	25.73	5.36
T_{13}	3.90	0.39	26.20	5.29
T_{14}	4.00	0.41	27.50	5.73
T_{15}	4.40	0.47	29.06	6.81
T_{16}	4.48	0.48	30.10	8.07
T_{17}	3.52	0.37	29.41	8.29
T_{18}	4.51	0.51	29.77	8.43
T_{19}	4.59	0.53	30.59	8.62
T_{20}	4.62	0.54	30.82	9.31
T_{21}	4.75	0.57	32.35	9.88
T_{22}	2.95	0.31	30.95	10.65
T_{23}	5.01	0.80	33.82	11.79
T_{24}	4.82	0.61	35.51	12.80
T_{25}	0.90	0.25	21.10	2.75
SE (m) ±	0.17	0.01	0.83	0.50
CD (*P*=0.05)	0.01	0.08	0.08	0.01

Table 4. Influence of organic manure and inorganic fertilizer on the RGR of the bulb and partitioning ratio of LA hybrid lilium cv. 'Masai'

Treatments	RGR of the bulb (mg g-1 day-1)	Partitioning ratio at the flowering stage	Partitioning ratio at bulb harvesting Stage
Organic manure (F)			
T_1	20.10	0.13	0.49
T_2	20.59	0.16	0.50
T_3	20.83	0.17	0.50
T_4	21.04	0.18	0.51
SE (m) ±	0.02	0.02	0.005
CD (*P*=0.05)	0.001	0.006	0.006
Inorganic fertilizer (N)			
T_5	16.05	0.20	0.41
T_6	18.90	0.13	0.41
T_7	19.80	0.16	0.43
T_8	20.09	0.20	0.45
SE (m) ±	0.02	0.02	0.005
CD (*P*=0.05)	0.001	0.006	0.006
Interaction (F*N)			
T_9	21.00	0.14	0.53
T_{10}	21.20	0.14	0.51
T_{11}	20.30	0.15	0.51
T_{12}	21.53	0.16	0.59
T_{13}	20.01	0.16	0.57
T_{14}	21.72	0.17	0.61
T_{15}	21.89	0.17	0.69
T_{16}	22.19	0.16	0.64
T_{17}	22.30	0.16	0.64
T_{18}	22.55	0.18	0.66
T_{19}	22.75	0.18	0.50
T_{20}	22.90	0.19	0.66
T_{21}	23.10	0.19	0.69
T_{22}	23.50	0.17	0.72
T_{23}	23.80	0.19	0.76
T_{24}	24.01	0.22	0.80
T_{25}	15.50	0.12	0.30
SE (m) ±	0.22	0.04	0.02
CD (*P*=0.05)	0.03	0.01	0.01

in the roots and shoots of lilium, as observed by Kawagishi and Miura (1996), with similar findings reported for lilium by Su *et al.* (2012).

Significant variations were also found in the interaction effects. The T_{24} exhibited the highest bulb RGR (24.01 mg g^{-1} day^{-1}), partitioning ratio at flowering (0.22), and partitioning ratio at harvesting (0.80). Conversely, the control treatment showed the lowest bulb RGR (15.50 mg g^{-1} day^{-1}), partitioning ratio at flowering (0.12), and partitioning ratio at harvesting (0.30) (Table 4). This difference could be attributed to the combined effect of FYM and inorganic fertilizers on nutrient availability and dry matter accumulation. Adding organic manure to the soil and inorganic sources enhances nutrient availability, such as phosphorus, which plants can readily absorb. Moreover, FYM aids in improving nutrient absorption, enhancing meristematic activity, and accumulating photosynthates. These results align with previous findings that demonstrated increased RGR with four split nitrogen applications in gladiolus corm growth (Nonnecke, 1989).

In summary, the integration of organic and inorganic nutrients significantly improved the quality characteristics of bulbs and bulblets in LA hybrid lilies, especially with treatment T_{24} (FYM @ 25 t/ha + $N:P_2O_5:K_2O$ @ 160:120:100 kg/ha), showing remarkable effects. The findings indicate that both types of nutrients are effective in promoting the growth of bulbs and bulblets. Further studies are required to investigate the influence of higher nutrient dosages on the yield of bulbs and bulblets, as well as the role of additional micronutrients in the protected cultivation of LA hybrid lilium.

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