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Evaluation of Tuberose (*Agave amica* Medik.) Cultivars under Gangetic Region of Bihar

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Abstract

A study was conducted from April, 2024 to March, 2025 at Bihar Agricultural University, Sabour, Bihar, India to evaluate eighteen tuberose genotypes for their vegetative, floral, and bulb yield traits under subtropical conditions. Tuberose (*Agave amica* (Medik.)), an economically important ornamental bulbous plant in the family Asparagaceae, is extensively cultivated for its fragrant white flowers, which are used in both the loose and cut flower markets, as well as in the perfume industry for essential oil extraction. The experiment followed a Randomized Block Design (RBD) with three replications. The observations were systematically recorded on various vegetative, floral, and reproductive parameters. Significant variability was observed among the evaluated tuberose genotypes for both vegetative and floral traits, indicating the presence of considerable genetic diversity. The genotypes Prajwal and GKTC-4 exhibited superior performance with respect to plant height, spike length, rachis length, and number of florets per spike. While Arka Nirantra recorded the highest bulb production per hill, demonstrating its potential for use in large-scale propagation and commercial multiplication programs. Earliness-related traits were also distinct across genotypes, with Pearl Double showing the earliest sprouting of bulbs, while Hyderabad Single attained the earliest spike emergence and flowering. Genotypes excelling in floral traits may be targeted for cut-flower and loose-flower markets, whereas those with higher bulb multiplication capacity may serve as valuable resources for propagation, varietal improvement, and germplasm conservation. The identified genotypes offer potential for targeted use in floriculture and breeding programs aimed at enhancing yield and quality traits in tuberose.

Keywords: Tuberose, floral traits, spike length, bulb yield, evaluation

1. Introduction

Tuberose (*Agave amica* (Medik.)), formerly known as *Polianthes tuberosa*, is one of the most commercially significant ornamental bulbous plants in the family Asparagaceae (Bharathi et al., 2024). Renowned for its aesthetic elegance and intoxicating fragrance, tuberose has secured a unique position in both domestic and international floriculture markets (Rafique et al., 2025). Cultivated widely across tropical and subtropical regions, including India (Kaur et al., 2024), it is cherished not only for its ornamental value but also for its multifaceted commercial applications. Its regional names in India reflect its cultural resonance and widespread use; it is known as *Sempengi* in Tamil, *Nishigandhi* in Malayalam, *Rajanigandha* in Hindi and Bengali, *Nishigandha* in Marathi, Gulchadi (Gujrati) and *Gul-e-Shabab* in Urdu (Randhawa et al., 2001; Biswas et al., 2002). Tuberose enjoys dual commercial importance as both a cut flower and a loose flower. Loose flowers are integral to social and religious life in India and many Asian countries. They are extensively used in garlands, temple offerings, wedding decorations, and personal adornment (Anonymous, 2023). On the other hand, the long, sturdy spikes of tuberose, adorned with waxy white florets, are highly valued as cut flowers for bouquet preparation, table decorations, and floral arrangements. Their long vase life and enchanting fragrance make them particularly attractive for the domestic market and export trade (Vijayalakshmi and Rao, 2014).

Beyond its decorative uses, tuberose is globally recognized for its essential oil, which is one of the most expensive natural floral extracts. The fragrant white blooms yield an essential oil content ranging from 0.08% to 0.14%, depending on the variety. Tuberose concrete and absolute, derived from the blossoms, are in high demand globally, particularly in the perfumery industry. The export potential remains strong, with countries like France and Italy importing high-quality tuberose oil at premium prices due to its unique and enduring fragrance profile (Sadhu and Bose, 1973). The oil is also gaining recognition in the aromatherapy and wellness industries, further enhancing its commercial value. According to recent market analyses, the demand for natural floral absolutes such as tuberose continues to expand, driven by luxury fragrance brands that highlight authenticity and sustainability (Anonymous, 2025). The global tuberose extract market, valued at US$244.6 million in 2022, is projected to grow to US$413.5 million by 2032 (Anonymous, 2022). In India, the cultivation of tuberose is primarily concentrated in specific agro-climatic zones such as West Bengal, Karnataka, Maharashtra, and Andhra Pradesh, where the crop thrives under optimal growing conditions (Singh et al., 2025). Commercial cultivation of tuberose in India is mainly confined to warm and humid areas with an average temperature of 20-35°C (Lalthawmliana et al., 2017). It grows well in tropical and subtropical climatic conditions. The tuberose does not come up well in temperate conditions so it is limitedly grown in temperate conditions. Tuberose can be grown on almost all types of soil, but its production in terms of flower and bulb yield is highly influenced by soil physical and chemical properties (Noghani et al., 2012). They are heavy feeders and require a high amount of organic and inorganic fertilizers to maintain sustainable growth and flowering over a long period (Amarjeet et al., 1996). Genetic diversity among tuberose cultivars offers a valuable opportunity to select promising genotypes based on agronomic performance. Genetic variability existing among genotypes is the prime and basic factor for the improvement of any character in a successful breeding programme of tuberose (Sathappan, 2018). The present study was undertaken to assess variability among eighteen tuberose genotypes and identify superior performers for use in commercial cultivation and breeding programs.

2. Materials and Methods

The present experiment was conducted at the Botanical Garden, Department of Horticulture (Floriculture and Landscaping), Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India, during April, 2024 to March, 2025. The Botanical Garden, Bihar Agricultural University, Sabour is located at 25°15’40” N latitude and 86°57’00” E longitude, situated on the southern banks of the Ganges River, with a semi-arid to sub-humid subtropical climate. The maximum summer temperature ranges from 35°C to 42°C, while winter temperatures can fall to around 8.5°C. The region receives an average annual rainfall between 1100 and 1200 mm, primarily during the monsoon months from June to September. 18, cultivars of tuberose (*Agave amica* Medik.) were evaluated, comprising both single and double types. Uniform-sized bulbs (2 cm in diameter) were treated with 0.2% carbendazim solution and planted at a spacing of 30×30 cm^2. The experimental design followed was a Randomized Block Design (RBD) with three replications. Uniform cultural practices such as irrigation, weeding, earthing-up, and pest management were adopted across all treatments. Intercultural operations were done 30 and 50 days after planting to ensure weed control and proper aeration. The spikes were harvested when 2–3 florets opened and bulbs were lifted 45–60 days after spike harvesting. The observations were recorded for vegetative growth, floral traits, and bulb yield parameters. All recorded data were statistically analysed following the methods described by Panse and Sukhatme (1985).

3. Results and Discussion

3.1. Days to sprouting

Significant differences were observed among genotypes for days to sprouting (Table 1). The earliest sprouting was recorded in Pearl Double (7.07 days), followed closely by Hyderabad Double (7.33 days) and Kalkata Double (7.73 days). Delayed sprouting was noted in Bidhan Pearl (10.60 days) and Bidhan Snigdha (9.60 days). Early sprouting is desirable for rapid crop establishment, and these genotypes may be utilized in early flowering breeding programs. Similar results were reported by Ayushman and Fatmi (2024) in varietal trials, who reported significant differences in sprouting behaviour among tuberose varieties and highlighted the importance of early sprouting genotypes for crop improvement.

3.2. Plant height

Significant differences in plant height were observed among the genotypes, ranging from 57.97 cm in Bidhan Snigdha to 80.07 cm in Prajwal. Other tall genotypes included GKTC-4 (73.43 cm), Bidhan Ujjwal (73.43 cm), and Arka Nirantra (72.53 cm), indicating their superior vegetative growth. Taller plants often correlate with improved spike length and flower display, attributes highly valued in cut flower markets. Similar trends were reported by Kaur et al. (2023), who found maximum plant height in the Prajwal variety of tuberose. These results are in agreement with those reported by Tamrakar and Alka (2024) in tuberose.

3.3. Number of leaves

The number of leaves $plant^{-1}$ showed wide variation, ranging from 46.33 in Pearl Double to 59.13 in GKTC-4. High leaf count was also recorded in Bidhan Ujjwal (59.00), Hyderabad Single (56.33 cm), and Arka Nirantra (55.67). Leaf production contributes to photosynthetic capacity and overall plant vigour. Genotypes with more leaves typically have higher resource accumulation, which may translate to improved flowering and bulb production. The variation in the number of leaves per hill is attributed by the hereditary traits which are further modified by the environmental factors like temperature, relative humidity and light intensity (Hasna and Manjusha, 2021). This is in agreement with the findings of Jadhav et al. (2020).

Table 1: Performance of tuberose cultivars with respect to vegetative, floral and yield parameters

Genotypes	Days to sprouting	Plant height (cm)	No. of leaves	Length of longest leaf (cm)	Days to spike emergence	Days to first floret opening	Spike length (cm)	Rachis length (cm)	No. of Florets spike^{-1}	No. of spikes plant^{-1}	No. of bulbs hill^{-1}
Kalkata double	7.73	67.40	50.33	65.20	106.07	125.47	73.30	37.03	32.87	2.13	7.00
Arka Nirantra	8.13	72.53	55.67	70.40	84.40	112.20	87.77	45.73	43.67	2.47	9.60
GKTC-4	8.47	73.43	59.13	71.30	95.20	107.00	87.70	42.07	53.80	2.60	9.13
Bidhan Pearl	10.60	65.30	48.20	57.57	109.60	142.53	69.19	33.67	34.80	2.07	7.80
Prajwal	8.27	80.07	57.20	76.73	83.60	100.87	91.14	43.07	44.40	2.40	8.33
Bidhan Ujjwal	8.33	73.43	59.00	66.43	90.97	104.87	67.13	32.60	27.00	2.80	9.33
MUAT Pratap Rajni	8.73	66.30	53.67	57.53	108.20	140.40	63.67	31.73	26.07	2.20	7.73
Phule Rajani	9.47	69.63	52.33	65.10	103.87	138.13	87.87	41.33	40.27	2.20	8.20
Sikkim selection	8.87	63.63	48.00	65.53	114.60	149.53	87.60	39.14	37.47	1.73	7.00
Arka Kirthi	9.20	70.30	56.20	67.93	94.23	110.60	71.31	36.05	35.67	2.33	8.40
Srinagar	8.40	66.93	49.87	67.60	113.27	143.27	87.43	39.59	42.27	1.80	6.93
Syadri Vaman	9.33	62.23	47.27	50.57	117.67	149.00	48.97	29.90	23.00	1.67	6.80
Hyderabad Double	7.33	61.77	49.67	64.47	116.47	147.80	71.48	36.80	36.47	1.73	6.87
Mexican Single	7.53	62.23	49.00	54.73	113.67	145.67	66.12	33.17	32.00	1.87	7.13
Bidhan Snigdha	9.60	57.97	46.47	65.53	122.87	145.53	84.93	39.34	39.07	1.47	4.00
Hyderabad single	8.07	70.50	56.33	66.43	70.60	107.53	72.75	38.33	37.27	2.27	9.00
Pearl double	7.07	61.70	46.33	60.40	123.33	142.47	66.58	33.30	32.53	1.60	5.00
Suvasini	8.13	66.93	49.93	64.97	109.93	138.00	53.40	31.73	23.13	2.00	7.40
SEm±	0.26	1.30	1.41	2.04	3.02	3.17	1.46	1.02	1.20	0.10	0.27
CD (p=0.05)	0.76	3.72	4.06	5.86	8.69	9.10	4.19	2.92	3.45	0.29	0.77
CV %	5.37	3.33	4.72	5.50	5.02	4.20	3.39	4.77	5.83	8.53	6.12

3.4. Length of longest leaf

A wide range of variability was observed among the genotypes for leaf length. The maximum leaf length was recorded in Prajwal (76.73 cm), followed by GKTC-4 (71.30 cm) and Arka Nirantra (70.40 cm), whereas the shortest leaves were noted in Syadri Vaman (50.57 cm). Longer leaves contribute to greater light interception and enhanced photosynthetic efficiency, which in turn support vigorous vegetative growth and improved spike development. The positive association between leaf length and floral traits observed in the present study aligns with earlier findings (Safeena et al., 2019, Gogoi et al., 2019) showing significant positive correlation of leaf length with number of florets per spike and spike yield. More recently, studies by Kayalvizhi et al. (2023) further confirmed that leaf length is significantly correlated with vegetative vigour, spike weight and yield components in tuberose. These results collectively demonstrate that leaf length is not merely a morphological trait but is an important physiological indicator influencing overall floral yield potential in tuberose.

3.5. Days to spike emergence

Spike emergence was earliest in Hyderabad Single (70.60 days), followed by Prajwal (83.60 days) and Arka Nirantra (84.40 days). The latest spike emergence was recorded in Pearl Double (123.33 days) and Bidhan Snigdha (122.87 days). Early spike emergence is advantageous for early market supply and staggered production planning. Delayed spike appearance in tuberose cultivar Pearl Double was reported by Bharathi et al. (2021) who noticed a wide range of variation in days taken to spike emergence due to variation in genetic makeup and prevailing environmental conditions.

3.6. Days to first floret opening

Floret opening followed a similar trend to spike emergence. The earliest opening was observed in Prajwal (100.87 days), followed by GKTC-4 (107.00 days) and Hyderabad Single (107.53 days). Genotypes like Sikkim Selection (149.53 days) and Syadri Vaman (149.00 days) were the latest to flower. Earliness in flowering is a key trait for commercial exploitation and off-season production. A longer time to flowering (164 days) was recorded in Sikkim Selection by Ayushman and Fatmi (2024).

3.7. Spike length

A wide range of variability was recorded among the tuberose genotypes for spike length. In the present study, spike length varied from 48.97 cm in Syadri Vaman to 91.14 cm in Prajwal. Genotypes such as GKTC-4 (87.70 cm) and Arka Nirantra (87.77 cm) also produced notably long spikes, reflecting superior floral growth potential. Longer spikes are commercially desirable because they improve visual appeal, enhance consumer preference, and command higher market prices in the cut-flower industry. The positive influence of genotype on spike length observed here aligns with earlier reports by Prakash et al. (2015) and Safeena et al. (2019), who documented significant genotypic differences for spike length in tuberose. Their findings also indicated that longer spikes often support higher floret density and better spike architecture, making such genotypes suitable for commercial cultivation and breeding programmes aimed at improving cut-flower quality. The agreement between present results and earlier studies reinforces the role of genotype in determining spike length and overall floral value in tuberose.

3.8. Rachis length

Significant genotypic variation was observed for rachis length among the evaluated tuberose genotypes. In the present study, rachis length ranged from 29.90 cm in Syadri Vaman to 45.73 cm in Arka Nirantra, while genotypes such as GKTC-4 (42.07 cm) and Prajwal (43.07 cm) also exhibited comparatively long rachis values. A longer rachis enhances spike architecture by allowing better spatial arrangement of florets, thereby improving visual appeal and overall spike quality. This trait is commercially desirable because a longer rachis with closely arranged florets gives the spike a compact, well-structured, and visually appealing appearance (Hasna and Manjusha, 2021). Similar observations of significant genotypic differences in rachis length were reported by Prakash et al. (2015), Bharathi and Umamaheswari (2018), and more recently by Kaur et al. (2023) and Kayalvizhi et al. (2023). The agreement between present findings and previous studies reinforces the conclusion that rachis length is a critical trait influenced by genotype and strongly associated with market preferred floral characteristics in tuberose.

3.9. Number of florets spike^{-1}

A wide variation was recorded among the tuberose genotypes for the number of florets per spike, ranging from 23.00 in Syadri Vaman to 53.80 in GKTC-4. Genotypes such as Prajwal (44.40) and Arka Nirantra (43.67) also exhibited high floret numbers, reflecting superior genetic potential for floral productivity. A greater number of florets per spike is commercially desirable because it improves the spike length, aesthetic appeal, and overall market value of cut flowers. The significant genotypic influence on floret production observed in this study is consistent with earlier findings that reported considerable variability among tuberose cultivars for spike and floret traits (Bharathi et al., 2021, Singh et al., 2021). Recent studies further validate this pattern, highlighting that genotypes with strong vegetative vigour and balanced assimilate allocation tend to produce higher floret numbers per spike (Ayushman and Fatmi, 2024, Wakade et al., 2025). These findings collectively reinforce the importance of genotype selection for improving floret density and floral quality in tuberose.

3.10. Number of spikes plant^{-1}

Significant variation was observed among the genotypes for the number of spikes produced plant^{-1}, highlighting the strong influence of genetic makeup on floral yield potential. Among the evaluated genotypes, Bidhan Ujjwal produced the highest number of spikes (2.80), which remained statistically at par with GKTC-4 (2.60), whereas the minimum spike production was recorded in Bidhan Snigdha (1.47). The increased spike production in certain genotypes may be attributed to better resource allocation, greater physiological vigour, and enhanced floral shoot initiation. Spike productivity was closely associated with supporting vegetative traits such as the number of leaves plant^{-1}, number of shoots plant^{-1}, and the number of bulbs hill^{-1}, indicating an integrated influence of multiple factors on floral yield. These observations confirm the significant role of genotype in determining spike production potential. Similar genotype dependent variability in spike production and its linkage with vegetative vigour has been reported earlier in tuberose by Dimri et al. (2017), Sathappan (2018). More recent studies have also confirmed considerable genetic variation for spike yield and related traits across diverse environments (Sarkar et al., 2023, Wakade et al., 2025).

3.11. Number of bulbs hill^{-1}

Bulb multiplication exhibited significant genotypic variation among the evaluated tuberose genotypes. The highest number of bulbs hill^{-1} was recorded in Arka Nirantra (9.60), followed by Bidhan Ujjwal (9.33) and Hyderabad Single (9.00), whereas the minimum was observed in Bidhan Snigdha (4.00). High bulb production is an important commercial trait because it enhances multiplication rate, ensures rapid field scale propagation, and reduces the recurring cost of planting material. The observed genotypic differences may be attributed to inherent variability in resource allocation efficiency, physiological vigour, and bulb initiation potential. Similar genotype dependent variation in bulb yield has been reported in earlier studies on tuberose (Rao and Sushma, 2015, Chawla et al., 2019). Recent findings also confirm substantial variability in bulb multiplication and its association with vegetative vigour and flowering efficiency (Alka and Tamrakar, 2024). Collectively, these studies support the present results and highlight that selection of genotypes with superior bulb production capacity is crucial for commercial cultivation and propagation programmes in tuberose.

4. Conclusion

The evaluation of eighteen tuberose genotypes under the agro-climatic conditions of Bihar revealed considerable variability in vegetative, floral, and propagation traits. Among the tested genotypes, Prajwal, GKTC-4, and Arka Nirantra proved to be superior, exhibiting tall plant stature, longer spikes, higher floret count, and better bulb multiplication, making them suitable for commercial cultivation. Hyderabad Single was identified as an early-flowering genotype, while Pearl Double exhibited early sprouting.

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