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Original Research

Assessing Synergistic Effect of Mulching, Micronutrients and Plastic Tunnel on Growing Period and Morphological Characteristics of Tuberose (*Polianthes tuberosa*) cv. Single

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ABSTRACT

A field experiment was conducted to evaluate the individual and combined application of mulching, nutrients, and plastic tunnel on the growth period and floral characteristics of tuberose (*Polianthes tuberosa* L.) cv. Single. The results of this study showed that the utilization of mulch and low tunnel together significantly enhanced vegetative and floral attributes of tuberose cv. Single. The plants grown under mulch and low tunnel conditions showed earliest bulb sprouting (37.1 days), leaf emergence (39.2 days), spike emergence (47.1 days), and florets emergence (223.9 days). The highest plant height (104.1 cm), and number of florets per spike were also obtained with combined use of low tunnel and plastic mulch. However, the highest numbers of leaves (17.8) were noted under low tunnel conditions and the highest spike length (49.6 cm) with the use of mulching in combination with humic acid. Furthermore, the thickest spike (5.95 mm) was found with foliar application of nutrients on plants grown under plastic mulch. In conclusion, the combined use of low tunnel and plastic mulch is recommended for obtaining early production and rec desirable characteristics in tuberose cv. Single.

Keywords: *Calcium carbide, early crop, humic acid, spike length.*

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INTRODUCTION

Tuberose (*Polianthes tuberosa* L.) is a famous bulbous perennial grown as a bedding plant and cut flower worldwide. It is an important cut flower (Muriithi et al., 2011) and is widely cultivated during summers due to its attractive foliage, long vase life and essential oil industry (Mudassir et al., 2021). It is commonly grown in the peri-urban districts of Multan, Lahore, Pattoki, Sheikhupura, Faisalabad, Quetta, Islamabad, Rawalpindi, Hyderabad, and Karachi (Shahzad et al., 2021). Commercial cultivation of tuberose is practised in the United States, China, Taiwan, New Zealand, Netherlands, Rwanda, Japan, South Africa, Mexico, France, Egypt, Italy, and India (Barba-Gonzalez et al., 2012).

The increased early season yield, and better quality are critical components of high turn (Dhatt et al., 2017). By extending the harvesting time and altering the growth phase, it is intended to produce crops where they would not otherwise be able to thrive (Adamović et al., 2021). This results in the availability of commodities when outdoor production is not possible and earlier maturity, higher yields, and better quality. The majority of Pakistan's soils have an alkaline pH, which makes it difficult for micronutrients to be absorbed. One way to address this problem in plants is to apply specific micronutrients to plants to improve plant's structure and physiological functions through foliar spray (Jatav et al., 2020). They are considered the prerequisites for high-quality production of spikes and bulbs (Olasantan, 1999).

According to an estimate, approximately 60% of the soil's organic matter originates from humic acid (Varanini and Pinton, 2006). It has been shown that in soils with limited organic matter, humic acid exhibits the best outcomes in terms of plant development. Therefore, it is imperative to ascertain the soil's organic matter content prior to applying humic acid (Ramakrishna et al., 2006). Plastic mulches are useful for plant microclimate by changing the soil energy balance and reducing evaporation from the soil, therefore helpful for better plant

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growth and yield. Black plastic mulch used in crop production, was a dark but not transparent black body that acts as a radiator and absorber (Singh et al., 2005). The efficiency with which black plastic mulch increases the temperature of the soil can be increased by optimizing the heat transfer to the soil from the mulch (Doring et al., 2005).

Considering all the above approaches for improving early and high-quality production of tuberose, a field experiment was conducted to determine the effects of the low tunnel, humic acid, and micronutrients on tuberose (*Pollianthes tuberosa* L.).

MATERIALS AND METHODS

Treatment plan

The study was conducted from March to September 2019 at the Islamia University of Bahawalpur, Pakistan. The photoperiod was about 14 hours of daylight with 29/20°C (day/night) temperature and 75% relative humidity. The bulbs of tuberose cv. Single was purchased from a certified nursery in Pattoki, Punjab, Pakistan, and planted on ridges in sandy loam field soil. The electrical conductivity and pH of the soil were 0.97 dS m^{-1} and 7.9, respectively.

Experimental setup

The present study comprised eight treatments, each of which was replicated four times. The treatments included control; mulch, low tunnel, mulch + low tunnel, calcium carbide; humic acid; micronutrients, mulch + calcium carbide; mulch + humic acid; mulch + micronutrients. Humic acid (8%) was applied by soil drenching. With a concentration of 5–6 ml100 ml^{-1}, micronutrients were applied by foliar application. Each treatment included 20 plants. The distance between plants and ridges was maintained at 15 and 45 cm, respectively. The first irrigation was applied immediately after planting, while other irrigations were applied according to temperature and climatic conditions.

Morphological attributes

The number of days from the planting to the sprouting was counted. The first leaf emergence was computed from the planting date to the first leaf emergence. The plant height was recorded at two stages: first when the low tunnels were removed. Then, again, when the plants were in full bloom. The number of leaves was counted at full maturity. The time to first floret-emergence was determined by counting the number of days to the first appearance of flowers. The number of florets per spike was counted at full maturity. Similarly, the days to spike emergence were also calculated. The length of the spike was measured with measuring tape. Likewise, the width and thickness of the florets were measured.

Statistical analysis

The analysis of variance (ANOVA) was carried out on the obtained data with the aid of Statistix 8.1. The least significant difference (LSD) test was used to compare the treatment means. The probability level for ANOVA and LSD mean comparison was

Table 1: Effect of different treatments on vegetative growth attributes of tuberose (*Polianthes tuberosa* L.).

	Control	Mulch	Low tunnel	Mulch + Low tunnel	CaC_2	Humic acid	Micronutrients	Mulch + CaC_2	Mulch + Humic acid	Mulch + Micronutrients	LSD
Sprouting period (days)	78.07a	63.98b	43.42d	37.03e	78.07a	77.62a	77.75a	63.98b	61.8bc	60.87c	2.20
Days to leaf emergence	79.91a	64.86c	44.38d	36.12e	77.46a	75.98a	71.59b	64.3c	65.12c	63.42c	4.29
Days to spike emergence	87.89a	73.68a	53.30c	47.16d	85.52a	87.32a	85.25a	71.68b	71.60b	70.95b	4.30
Plant height (cm)	87.15f	102.5ab	94.95d	104.1a	97.7bcd	98.7bcd	96.30cd	100.6abc	97. 31cd	101.1abc	4.93
PHWTR* (cm)	15.51e	21.35c	28.96b	37.59a	14.39e	14.75e	17.94d	19.64cd	18.70d	21.05c	2.24
Number of leaves	16.32ab	18.08a	18.12a	17.47ab	16.87ab	17.75a	16.91ab	17.00ab	15.25b	15.72ab	2.12

* Plant height when tunnel removed.
Each value is the mean of four replications ± SE. Dissimilar lettering illustrates significant differences at $p \leq 0.05$ after applying LSD test. Abbreviation: LSD – Least Significant Difference test.

Table 2: Effect of different treatments on floral traits of tuberose (*Polianthes tuberosa* L.).

	Control	Mulch	Low tunnel	Mulch + Low tunnel	Calcium carbide	Humic acid	Micronutrients	Mulch + CaC_2	Mulch + Humic acid	Mulch + Micronutrients	LSD
Florets emergence period (days)	263.2a	240.5b	236.7bc	223.9f	234.9cd	233.9cd	233.6cd	230.3de	227.2ef	230.4de	5.52
Number of florets per spike	39.5ab	38.8a-c	38.2abc	42.6a	34.7cd	35.3b-d	39.8ab	36.2bcd	37.8cd	32.0d	4.81
Length of spike (cm)	38.8b	39.7b	39.4b	41.1b	39.8b	38.4b	39.8b	49.5a	49.5a	42.5b	3.74
Thickness of spike (mm)	4.9b	4.8b	4.9b	4.9b	5.2ab	5.3ab	5.95a	5.2a	5.2a	5.8a	0.70
Floret diameter (mm)	36.1b	36.2b	36.7ab	36.1b	32.3c	32.5c	38.87a	30.6cd	30.6cd	36.8ab	2.43
Earliness (days)	0.0h	27.4d	35.5b	41.7a	19.0f	14.3g	31.3c	23.7e	23.7e	30.8c	1.61

* Plant height when tunnel removed.
Each value is the mean of four replications ± SE. Dissimilar lettering illustrates significant statistical differences at $p \leq 0.05$ after applying LSD test. Abbreviation: LSD – Least Significant Difference test.

kept 5% or below ($p \leq 0.05$).

RESULTS

Vegetative attributes

The plants grown under low tunnel + mulch conditions took the shortest period to sprout (37.03) compared to the control plants which took the longest period to sprout (78.07) (Table 1). The control plants took a shorter period to sprout, and the plants underwent the alone application of humic acid and micronutrients (Table 1). The plants grown under low-tunnel and mulching conditions had a shorter period of leaf emergence compared to the control (Table 1). The spike emergence took place in 47.2 days in the plants grown under low tunnel + mulching conditions (Table 1). Additionally, the plant height at the time of the tunnel's removal was found to be greater (37.6 cm) compared to the rest of the treatments (Table 1). The leaf count per plant varied across all treatments, ranging from 15.3 to 18.1 (Table 1).

Floral attributes

The plants raised on mulched soil under low tunnel developed flowers earlier than compared to other treatments; however, the plants on mulched soil, along with humic acid application, produced the most florets (Table 2). The highest number of florets per spike (42.56) was also noted in the plants grown under low tunnel + mulching conditions. The lowest number of florets per spike (32.0) was noted in the plants grown on mulched soil and received foliar spray of nutrients (Table 2). The plants grown on the mulched soil and receiving calcium carbide or humic acid were found to have the thickest spikes, respectively, whereas the control plants and those receiving micronutrients had the thinnest spikes (Table 2). Plants belonging to the T6 group had the largest floret diameter, measuring 38.87 mm.

The earliness in terms of the shortest period to flowering was observed in the plants grown on mulched soil under low tunnel, while the longest period to flowering was noted in the plants receiving humic acid.

DISCUSSION

The improvement in early flower production and quality is an utmost challenge for every flower grower. The results demonstrate that mulch and low tunnel in combination had a significantly higher impact on tuberose development and floral attributes compared to the rest of the treatments. Previously, a significant effect of plastic mulch on vegetative and reproductive attributes of dahlia plants has been reported (Dhatt et al., 2017). Moreover, a notable early appearance of leaves and sprouting was noted in the plants grown under mulch + low tunnel conditions. These findings are in good agreement with those of Saleem et al. (2002), who noted that mulch and low tunnels, in combination, had a considerable influence on plant sprouting and early leaf emergence. An early spike in production was also noticed in the plants under low tunnels and mulching together. The comparable findings were observed by Mahajan et al. (2007) showing that mulching keeps soil moisture from evaporating and hence promotes plant development and early

vegetative growth. According to Saleem et al. (2002) mulch and tunnels have a significant influence on early vegetative and floral characteristics. The highest height was noted in the plants grown under mulch + micronutrient conditions.

A plant's ability to grow its leaves to their maximum potential was greatly enhanced by mulching. The quantity of leaves per plant significantly improved with the use of plastic mulch (Dhatt et al., 2017). In addition, the floral responses of the plants to low tunnel + mulching were strong. The combined use of low tunnels and mulching had a significant influence on the vegetative growth of plants (Wu et al., 2006). The use of mulch and tunnel together had a significant effect on the length and thickness of spikes. These findings support the earlier investigations made by Awasthi et al. (2006) that using different mulching materials boosted plant height, spike length and thickness. However, the findings of Kolekar and Bhagyaresha (2018) showed that humic acid decreases the length of the spike and the number of branches per plant conflicts with our findings. Due to the florets' maximal diameter, micronutrients were the most important (Mudassir et al., 2021). This resulted in larger floret diameters because the plants received foliar application of micronutrients that were more readily available to them in soluble form (Kumar and Singh, 2020). Similar results were obtained by Niu et al. (2020), showing that the application of micronutrients improves floret size by increasing the diameter of the florets on plants, resulting in a form of greater floret diameter. A similar study revealed by Kumari et al. (2018) that the combination of mulch and low tunnel significantly increased earliness because it conserved moisture in the root zone and produced an environment that was more favourable for plant growth inside the tunnel.

CONCLUSION

Results can conclude that the combined application of mulch and low tunnel substantially induced early growth, high quality, and desired floral characteristics in tuberose (*Polianthes tuberosa* L.) cv. Single.

Declaration of competing interests

The authors declare no conflict of interest.

Author contribution statement

Muhammad Ahsan: Conceptualization, Methodology, Software, Data curation, Writing- Original draft preparation. **Adnan Younis:** Visualization, Investigation, Supervision. **Hera Gul:** Software, Validation, Writing- Reviewing and Editing.

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