Research Article

Production of Tuberose (*Polianthes tuberosa* L.) as Affected by Bulb Size and Planting Medium

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Abstract | Tuberose is an important element of a landscape garden. It is placed among top ten cut flowers in floriculture industry. Quality production of cut flowers for market depends upon bulb size and growing medium. To investigate the best type of planting medium and suitable bulb size for commercial production of tuberose, an experiment was conducted in the Horticulture Nursery, University of Swabi, Pakistan in the year 2019. Three bulb sizes of tuberose viz., large (2.5cm dia), medium (1.5cm dia) and small (1cm dia) were planted in three type of planting media viz., M1(Sandy soil+ Compost; 3:1; v/v), M2 (Sandy soil+ Humic acid; 20:1; v/v) and M3 (Sandy soil + Potting soil; 3:1; v/v) in Randomized Complete Block Design (RCBD) with 3 replications. Significant differences were found in all the agronomic and floral characteristics of tuberose for both planting medium and bulb sizes. Tallest (43.08 cm) plants, maximum number of leaves plant^{-1} (22.17), florets spike^{-1} (22.79) and number of bulblets produced plant^{-1} (22.03) were found in soil amended with humic acid. However, the least days (85.22) to flowering were observed in planting medium amended with potting soil and largest bulblets (2.14cm) were found in compost amended sandy soil. As far as the effect of bulb size is concerned, maximum days to flowering (97.44), plant height (43.29cm), number of leaves (24.54), number of florets (19.17), bulblets plant^{-1} (24.30) and bulblet diameter (2.08 cm) were produced by growing large sized bulbs.

Received | April 05, 2020; **Accepted** | October 12, 2020; **Published** | November 09, 2020
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Citation | Zamin, M., A. Muhammad, I. Jan, H. Ullah, S. Shah, M. Amin, H.U. Rashid. 2020. Production of tuberose (*Polianthes tuberosa* L.) as affected by bulb size and planting medium. *Sarhad Journal of Agriculture,* 36(4): 1156-1161.
DOI | http://dx.doi.org/10.17582/journal.sja/2020/36.4.1156.1161
Keywords | Bulb, Humic acid, *Polianthes tuberosa*, Potting soil, Propagation

Introduction

Tuberose (*Polianthes tuberosa* L.) is among commercial cut flowers. It belongs to family Amaryllidacea and is originated from Mexico. It is commercially used in landscape gardening and in the floriculture industry throughout the world. It is mostly grown in Morocco, France, Hawaii, South Africa, India and China (Naznin *et al.*, 2015). It is used for table purpose as cut flower because it has long spike length, long post-harvest life and extremely fragrance. It is commercially used for garland making, aesthetic purpose, birthday ceremony, floral arrangement such as; bouquets and in perfumes (Qureshi *et al.*, 2018; Ali *et al.*, 2019). It is also used in beverages and pharmaceuticals industry (Mandal *et al.*, 2018). Tuberose gives nice flowers in summer and autumn. Different sizes of bulbs affect the production and quality of tuberose flowers (Raja and Palanisamy, 1999; Aksu and Celikel, 2003). There is serious concern on

the injudicious use of inorganic fertilizers leading to environmental issues including deterioration of soil structure and health (Naznin *et al*., 2015; Singh, 2000), the use of organic fertilizers such as compost and humic acids is recommended (Mazhabi, 2010). In this way soil structure and nutrient uptake can be improved. Due to which the trend for organic farming is increasing day by day for quality and environment friendly crop production (Mazhabi, 2011a; Mitra, 2010). Tuberose requires a large quantity of nutrients. Thus, organic fertilizers have greater role in optimum growth and flower production (Singh, 2000; Naznin *et al*., 2015). Duration of flowering in the field can be improved through using organic fertilizer. Humic acid is an organic fertilizer, contains appropriate amount of macro and micro nutrients (Garg and Bahl, 2008). Research works have shown that compost, farmyard manure, cocopeat, vermicompost etc. not only act as mineral nutrition to plants but also improve the water retention potential of soil (Naznin *et al*., 2015). Organic amendments take part in stabilizing soil pH, improve the organic matter content in soil which lead to enhance plant growth and crop yield in terms of quality and quantity. Therefore, the current study was conducted to investigate optimum size of tuberose bulbs and planting medium for better commercial flower production and give maximum number of bulbils for further propagation.

Materials and Methods

The experiment was carried out during the year 2019 at the Ornamental Nursery of the Department of Agriculture, University of Swabi, Pakistan. Tuberose bulbs with three sizes viz., large (2.5cm dia), medium (1.5cm dia) and small (1cm dia) were planted in pots having 1 gallon volume filled with three kinds of planting media (sandy soil mixed with compost, humic acid and potting soil) in March 2019. Planting media used were comprised of M1 (Sandy soil+ Compost; 3:1; v/v), M2 (Sandy soil+ Humic acid; 20:1; v/v) and M3 (Sandy soil + Potting soil; 3:1; v/v). Potting soil is a brand name of organic fertilizer available in the market having rich nutrients. To prepare planting media, three containers having 1 gallons capacity of sandy soil were mixed with one gallon container of respective organic amendments to get a mix with 3:1; v/v. The mix was used for filling the pots for the experiment. In case of M2, 19 gallons sandy soil was mixed with 1 gallon humic acid using 1 gallon container. Randomized complete block design having two factors was used with 3 replications in the experiment. Before planting, anti-fungal solution (Bavistin) was applied to the seed bulbs for 30 minutes. Bulbs were sown in 10cm plastic pots filled with above planting media. Standard establishment and maintenance practices were carried out and data were recorded time to time for five growth and floral parameters viz., days to flowering, plant height (cm), number of leaves, number of flowers and bulblets produced and bulblets size (cm) as detailed below;

Number of days to flowering

Data were taken when 25% plants provided flowers in randomly selected 3 pots and average was taken.

Plant height (cm)

Plant height was recorded using measuring tape and the length from soil surface to the tip of the spike was taken from randomly selected plants and average was taken.

Number of leaves plant^{-1}

Leaves were counted in three randomly selected pots and average was calculated.

Number of florets spike^{-1}

The total number of florets were counted in a spike and recorded.

Number of bulbs produced plant^{-1}

After harvesting, all the bulbs were counted for this parameter.

Size (dia) of bulblets (cm)

Diameter of bulblets produced was measured using Vernier caliper.

Above data were subjected to analysis of variance using Statistix software version 8.1 and means were separated for each factor using LSD technique (Steel and Torrie, 1997) and explained as below.

Results and Discussion

Number of days to flowering

As indicated in Table 1, different bulb sizes, growing media and their interaction had a significant ($P \leq 0.001$) effect on number of days taken to flowering. The highest days (97.44) to flowering were noted in large bulbs followed by medium size taking 95.56 days to flowering while minimum days to

flowering (94.73) was noted in small bulbs. As far as planting medium is concerned, maximum (105.34) number of days were taken by bulbs grown in M1 (Sandy soil+ Compost; 3:1; v/v) while minimum (85.22) days were taken by plants grown in M2 (Sandy soil+ Humic acid; 20:1; v/v) as shown in Table 1. Early flowering is directly correlated with earliest bud formation in humic acid amended soil. It can also be attributed to more vegetative growth attaining a greater number of leaves in the medium which contributed significantly to accumulation of photosynthates and in turn inducing optimum growth, early bud formation and flowering. Seyedi *et al.* (2012) concluded that organic amendments in planting media can improve physical and chemical properties and thus probably makes better growth of plants to decrease days from planting to reproductive stage. Our results are in contrast to the findings of Naznin *et al.* (2015) where they found earliness due to larger bulbs as compared to smaller bulbs in gladiolus. This might be due the response of different species to bulb size. That is why Akand *et al.* (2016) found similar trend in days to flowering as affected by bulb size while working on tuberose.

Plant height (cm)

Data regarding plant height depicted that it was significantly (P≤0.001) affected by bulb size while non-significant effect was found in planting medium. The tallest plants were produced by large bulbs (43.29cm) followed by medium size (42.02cm) while minimum was recorded in small bulb producing 38.28 cm tall plants. As far as different growing media is concerned, tallest (43.08 cm) plants were observed in sandy soil amended with humic acid which was at par with the results obtained in case of M3 (sandy soil+ Potting soil; 3:1; v/v) while lowest height of plants (37.99 cm) was found in plants grown in planting medium of M1 (sandy soil+ compost; 3:1; v/v). The results of interaction were found significant as shown in Table 1. Soil with more nutritive status such as, in case of humic acid, gave better performance. Similar trend of increase in plant height due to nutrients rich media was also recorded by Singh (2013) in tuberose plants. As mentioned earlier, height in plants was increased upon increase in the bulb size. The present results are in conformity with that obtained by other researcher's work where they concluded that the best performance by larger bulbs may attributed to the higher reserve food in larger sized bulbs resulting into better growth and taller plants as compared to the smaller bulbs grown (Akand *et al.*, 2016; Mahanta *et al.*, 1998).

Number of leaves plant^{-1}

Data regarding number of leaves plant^{-1} revealed that it was significantly (P≤0.001) affected by bulb size and planting medium whereby maximum number (24.54) of leaves plant^{-1} was found in large bulb followed by number (22.77) of leaves in medium sized bulbs while the lowest number (16.24) of leaves were produced in small bulbs. As far as planting medium is concerned, bulbs grown in Sandy soil+humic acid resulted in maximum number (22.17) of leaves plant^{-1}. On the other hand, minimum leaves (20.30) were produced in Sandy soil+ compost (Table 2). Tuberose bulbs grown on M2 (Sandy soil+ Humic acid) produced maximum number of leaves plant^{-1}. The same media (M2) also gave maximum plant height. It might be due to increased water holding capacity and nutrient rich nature of humic acid amended soil (Tomati *et al.*, 1988; Moghadam *et al.*, 2012). Growing larger seeds produced a greater number of leaves plant^{-1} and bulbs with higher diameter were obtained at harvesting. The present results are also in accordance with the findings of Akand d*et al.* (2016).

Number of florets spike^{-1}

Bulb size, planting medium and their interaction significantly affected number of florets spike^{-1} of tuberose. Maximum number (19.17) of flowers spike^{-1} was recorded in large bulbs followed by medium (16.61) which was at par with small bulb (16.39). Varying performance was shown on different growing media also. Tuberose bulbs grown in Sandy soil+ Humic acid gave the highest number (22.79) of flowers followed by 17.05 florets spike^{-1} recorded in Sandy soil+potting soil while minimum (12.33) flowers produced in compost amended with sandy soil. Optimum growing conditions provided by the medium amended with Humic acid helped to optimize plant health resulting in the production of a greater number of florets spike^{-1}. Humic acid is a rich source of nutrients including both macro and micro. If mixed in other planting medium, could lead to a better soil for optimum plant growth (Sahni *et al.*, 2008). In a similar study on asiatic hybrid lily 'Navona', Moghadam *et al.* (2012) also reported a greater number of flowers spike^{-1} in amended medium. Similar results were obtained by Singh (2000) who found more florets in gladiolus when larger corms were sown.

Table 1: *Effect of planting medium and bulb size on number of days taken to flowering and plant height (cm) of tuberose (Polianthes tuberosa).*

Planting medium	Bulb size							
	Number of days to flowering				Plant height (cm)			
	Large	Medium	Small	Means	Large	Medium	Small	Means
M1 (Sandy soil+Compost; 3:1; v/v)	105.50	104.00	106.53	105.34a	39.47	38.34	36.15	37.99b
M2 (Sandy soil+ Humic acid; 20:1; v/v)	100.17	97.33	94.00	97.17b	44.93	41.80	42.50	43.08a
M3 (Sandy soil+ Potting soil; 3:1; v/v)	86.67	85.33	83.67	85.22c	45.47	45.91	36.20	42.53a
Means	97.44a	95.56b	94.73c		43.29a	42.02b	38.28c	
LSD (P≤0.001)	Bulb size (B): 0.7714				Bulb size (B): 1.0801			
	Planting medium (P): 0.7714				Planting medium (P): 1.0801			
	Interaction (BxP): 1.3361				Interaction (BxP): 1.8708			

Table 2: *Effect of planting medium and bulb size on number of leaves plant^{-1} and number of florets spike^{-1} of tuberose (Polianthes tuberosa).*

Planting medium	Bulb size							
	Number of leaves plant^{-1}				Number of florets spike^{-1}			
	Large	Medium	Small	Means	Large	Medium	Small	Means
M1 (Sandy soil+Compost; 3:1; v/v)	24.00	23.17	13.72	20.30c	12.93	12.13	11.93	12.33c
M2 (Sandy soil+ Humic acid; 20:1; v/v)	26.22	25.30	15.00	22.17a	23.63	22.53	22.20	22.79a
M3 (Sandy soil+ Potting soil; 3:1; v/v)	23.40	19.83	20.00	21.08b	20.94	15.17	15.03	17.05b
Means	24.54a	22.77b	16.24c		19.17a	16.61b	16.39b	
LSD (P≤0.001)	Bulb size (B): 0.5252				Bulb size (B): 1.1448			
	Planting medium (P): 0.5252				Planting medium (P): 1.1448			
	Interaction (BxP): 0.9097				Interaction (BxP): 1.9828			

Table 3: *Effect of planting medium and bulb size on number of bulblets plant^{-1} and bulblets diameter (cm) of tuberose (Polianthes tuberosa).*

Planting medium	Bulb size							
	Number of bulblets plant^{-1}				Bulblet dia (cm)			
	Large	Medium	Small	Means	Large	Medium	Small	Means
M1 (Sandy soil+Compost; 3:1; v/v)	24.00	23.17	13.72	20.30c	2.23	2.17	2.03	2.14a
M2 (Sandy soil+ Humic acid; 1:20; v/v)	25.50	25.10	15.50	22.03a	2.23	1.96	1.50	1.90a
M3 (Sandy soil+ Potting soil; 1:1; v/v)	23.40	19.83	20.00	21.08b	1.78	1.82	1.43	1.68b
Means	24.30a	22.70b	16.41c		2.08a	1.98b	1.66c	
LSD (P≤0.001)	Bulb size (B): 1.1448				Bulb size (B): 0.4747			
	Planting medium (P): 1.1448				Planting medium (P): 0.4747			
	Interaction (BxP): 1.9828				Interaction (BxP): 0.8223			

Number of bulblets plant^{-1}

According to Table 3, maximum bulblets (24.30) plant^{-1} were produced in large bulbs which were significantly (P≤0.001) different as compared to all other treatments whereas minimum number (16.41) of bulblets plant^{-1} were produced in small bulbs. As far as the planting medium is concerned, maximum (22.03) number of bulblets were produced in M2 (Sandy soil+ Humic acid; 20:1; v/v) while minimum bulblets were found in M3 (Sandy soil+ Potting soil; 3:1; v/v). As indicated in Table 3, larger bulbs sown produced large number of bulblets as compared to smaller bulbs which is complying with the findings of Startek and Wraga (1998). Our results are in line with the results of Sharma *et al.* (2008) in tuberose.

Size (dia) of bulblets (cm)

As indicated in Table 3, variations due to bulb size and growing media and their interaction had a significant effect on bulblets size. The largest (2.08 cm) bulblets were obtained from M1 (Sandy soil+Compost; 3:1; v/v) which was at part with M2 producing bulblets having diameter 1.91cm while smallest (1.68cm) bulblets were produced from M3 (Sandy soil+ Potting soil; 3:1; v/v). The same medium (M2) which is at par with M1 producing maximum plant height, leaves, florets and bulblets (Tables 1, 2 and 3). More number of days to flowering led the plants to have enough time for food production and translocation to bulblets which caused bigger sized bulblets in the M1 (Table 1). Similarly, as indicated in Table 3, the larger sized bulbs produced bigger bulblets. We can conclude that this is due to the availability of photosynthates in the plants. These results are in accordance with the findings of Ahmad *et al.* (2009) who observed positive relation between tuberose bulb size and the size of daughter bulblets.

Conclusions and Recommendations

Based on the study results, it is concluded that large tuberose bulbs (2.5 cm dia) could be planted in sandy soil supplemented with humic acid produced tuberose plants with better vegetative and floral attributes. Thus, recommended for commercial production of tuberose.

Acknowledgments

We are thankful to HEC for sponsoring the study under SRGP project.

Novelty Statement

Since tuberose is considered an important element in floriculture industry, its improved production technology shall be a value addition for farmer's products.

Author's Contribution

MZ contributed in data processing and interpretation of results and organized over all manuscript development. AM helped in data collection and record. IJ and HU facilitated the study and research activities. SS contributed in review of literature. MA contributed in analysis and discussion of results. HUR helped in manuscript review and improvement of introduction section.

Conflict of interest

The authors have declared no conflict of interest.

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