American-Eurasian J. Agric. & Environ. Sci., 13 (11): 1470-1475, 2013
ISSN 1818-6769

DOI: 10.5829/idosi.aejaes.2013.13.11.12257

Comparative Study of Different Techniques to Create Earliness and Improvement in Quality Characteristics of Tuberose (*Polianthes tuberosa* L.) cv. Double

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Abstract: This study was conducted on the effects of different techniques to improve plant growth characteristics and to create earliness in tuberose (*Polianthes tuberosa* L.) cv. Double. Main treatments included low tunnel, mulch, micronutrients, calcium carbide (CaC_2) and combination of these with each other. Plant growth and quality characteristics like plant height, number of leaves and florets, thickness of spike, floret diameter, days to bulb sprout, leaf, spike and floret emergence were assessed and at the end earliness was calculated. The statistical results of the study showed that micronutrients and its combination with mulch were best for improving all growth (vegetative and reproductive) and quality characteristics but low tunnel with combination of mulch put significant effects to create earliness (27.48 days) and it was dominated on all other treatments by providing suitable microclimatic conditions for plant growth and development. Unexpectedly calcium carbide did not perform well on all plant growth characteristics and produced minimum spike thickness (5.03 mm). Therefore, it was recommended that micronutrients and low tunnel with mulch were best for improving plant growth and quality characteristics and creating earliness, respectively in important flower crop of tuberose (*Polianthes tuberosa* L.) cv. Double.

Key words: Calcium carbide · Low tunnel · Micronutrients · Mulch · Tuberose

INTODUCTION

Tuberose (*Polianthes tuberosa* L.) cv. Double is valuable flower ornamentals that bloom during summer season. It is native to Mexico and belongs to family *Amarylladaceae*. It produces conspicuous and showy cut flower that are important as commercially and aesthetically [1]. It is getting more importance among growers and floriculturists due to its production in summer and autumn season due to the unavailability of other ornamental flowering bulbs during this period [2]. It is used in floral arrangements such as table decorations and floral bouquets because the flowers remain effectively attractive and fresh for relatively longer period of time when arranged in bowls. It is also an important flower in essential oil industry [3].

Improved quality and early production are imperative factors for warm season crop growers. The growers who have the ability to modify their climate have a competitive advantage over growers in the same region that do not have the ability to manipulate their climate for their crop production [4]. There are many ways to modify or control the environmental conditions that are ideally suited for plant growth but low tunnel and mulches are cheapest and easily available sources. In controlled environments plant root growth improved with increase in temperature from a minimum to an optimum temperature [5]. Weed control and water conservation are very important practices in agriculture. To achieve these objectives mulching is the common practice. Any material that spread on the soil surface to shield it from evaporation and solar radiation was known to be mulch. Many types of materials like grass, sand, wood, rice and wheat straw, plastic polyethylene sheaths, etc. are used as mulches. They increased water infiltration and moderate soil temperature during severe rain [6].

Foliar application was best method to decrease this malfunctioning of plants to absorb certain micronutrients in physiological processes and structure of plants [7]. Foliar application of Zn, Fe and Cu showed superior results with respect to growth, flowering and other yield characteristics of the crops [8] and micronutrients

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especially Zn was also useful for protecting the plants from diseases and environmental factors [9]. Encapsulated CaC_2 applied alone or along with chemical fertilizer appreciably augmented early panicle emergence, number of spikes and yield of the crops [10]. Keeping in view all the techniques for quality production and creating earliness in tuberose, a field experiment was envisaged on vital flowering crop of tuberose (*Polianthes tuberosa* L.) cv. double.

MATERIALS AND METHODS

Experimental Site: Present research trials were carried out at Floriculture Research Area, Institute of Horticultural Sciences, University of Agriculture Faisalabad (31°25' N, 73°09' E), Pakistan during 2011. After site selection soil was methodically leveled, prepared and blocks were laid out according to the layout of the experiment. While laying out 20 g of nitrogen and phosphorus m^{-2} was applied.

Treatments: The research trial was replicated four times and each replication was consisting of eight treatments. Main treatments were low tunnel, mulch, micronutrients, calcium carbide (CaC_2) and combination of these with each other. Low tunnels were prepared with the dimension of 4 feet high and 3 feet wide and black plastic sheets were used as mulch. Encapsulated paint coated calcium carbide (CaC_2) was delivered @ 200 mg $plant^{-1}$ and micronutrients was applied by foliar application with 5-6 ml per 100 ml concentration $plant^{-1}$. There were 18 plants in each treatment. Row to row and plant to plant distance was kept 45 cm and 15 cm respectively.

Cultural Practices: All plants were irrigated just after planting while other subsequent irrigations were applied at the interval of 12 days which was gradually reduced up to seven days from April to onward, due to increase in temperature. The mean monthly temperature during the study period has been presented in Table 1.

Data Collection: Sprouting date of all plants in each treatment was noted individually by counting the number of days from the date of planting to the day when bulbs were fully sprouted. Data regarding first leave emergence were calculated from the date of planting up to the day when first leaf was emerged. The height of all the plants was noted when low tunnels were removed. Plant height was also measured when plant was at full bloom stage. Numbers of leaves and florets per plant were counted when plants were fully sprouted. Days to spike emergence were counted from planting date to spike emergence date. Florets emergence date was observed from the date of sowing to first floret emergence date. Thickness of spike and diameter of florets were observed at full bloom stage. Consumer acceptability (flower shape, size in diameter and color) was assessed by using the scoring method suggested by Cooper and Spokas [11]. In this method scoring rate was ranged from 1-9 and then means values were recorded for analysis of variance. Where 1-3 was poor quality, 4-6 was intermediate quality and 7-9 was superior quality. At the end of experiment earliness were calculated among different treatments.

Table 1. Mean monthly temperature (°C)

Months	Mean minimum	Mean maximum
January	07.3	19.6
February	09.9	22.1
March	14.0	27.5
April	19.1	33.5
May	24.8	40.1
June	27.0	40.7
July	27.9	38.0
August	27.6	36.6
September	24.4	36.3

Statistical Analysis: The experiment was laid out according to randomized complete block design (RCBD) and means were compared by applying least significant difference (LSD) test at 5 % level of significance [12].

RESULTS AND DISCUSSION

Days to Bulb Sprout, Leaf, Spike and Floret Emergence: Results of the study indicated that there were significant differences among the treatments in case of days to bulb sprout (Table 2). Mulch with low tunnel had very positive effect on early sprouting of the bulbs followed by low tunnel while plants in control treatment were sprouted at the last of all plants sprouted in other treatments. This early sprouting is due to provision of ideal temperature for the crop germination inside the low tunnel and mulch. The suitable temperatures of air and soil were very helpful for enhancement of early plant germination [13]. Due to early bulb sprout, leaves and spikes were also produced within less number of days (Table 2). Similar results were reported by Olasantan [14] and concluded that mutual effect of low tunnel and mulch on early sprouting of the plants was remarkable due to moisture maintenance in the root zone and improvement of micro-environmental conditions in the tunnel that were

Table 2: Effects of different techniques on days to bulb sprout, leaf, spike and floret emergence

Treatments	Bulb sprout (Days)	Leaf emergence (Days)	Spike emergence (Days)	Floret emergence (Days)
Control	32.55 a	31.86 a	42.61 a	126.21 a
Mulch	23.46 cd	24.00 b	33.79 b	109.50 cd
Low tunnel	19.63 e	19.37 c	29.70 c	107.06 d
Mulch + low tunnel	13.68 f	14.63 d	24.89 d	100.94 e
Calcium carbide	27.41 b	31.86 a	42.61 a	116.85 b
Micronutrients	25.26 bc	30.70 a	42.64 a	116.93 b
Mulch + CaC_2	22.50 d	24.00 b	36.58 b	111.25 c
Mulch + Micronutrients	22.23 de	23.07 d	33.89 d	108.98 cd

required by the plants. Salman *et al.* [15] also stated that due to combine effect of mulch and tunnel, soil temperature increased that resulted in early vegetative growth of the plants. Elevated soil temperature was observed in this research trial under the influence of low tunnel and mulch in comparison to without tunnel and control treatments which enhanced vegetative growth and development at the initial stages of the crop development. Early flowering were also occurred in treatment of mulch with low tunnel (Table 2). These observations are in line with Ramakrishna *et al*. [16] who stated that plants under polyethylene and mulches generally grow energetically, large and produced early flowering.

Height of Plants after Tunnel Removal and at Full Maturity Stage: Low plastic tunnels were removed during the 2nd week of April due to increase of outside temperature of the environment. Height of plants was also measured at that time to check the growth differences inside and outside of the tunnels. Plants attained maximum height in treatment of low tunnel with combination of mulch followed by low tunnel treatment (Table 3) while control treatment produced plants with minimum height. Studies of Solaiman *et al*. [17] and Jamil *et al*. [18] also revealed that healthier and taller vegetative growth were observed with the plants under low plastic tunnel and black plastic mulch while minimum plant height were obtained in control treatment of the experiment. Results of Olasantan [14] are also in line with our results of maximum plant height in combination of mulch and low tunnel. Very significant increase in height of the plants grown under low tunnel and mulches has been found than plants in control treatment [19]. Height of plants was also measured when plants attained maximum height at full bloom stage. Mulch with micronutrients performed very well and plants in this treatment attained maximum height (Table 3). These observations were very similar with the findings of Wu *et al*. [20] that mulching material was helpful for the improvement of plant height. Our results are also in line with the findings of Chaudhry *et al*. [21] who observed that maximum plant height was measured under mulch through mechanical loosening of soil. It indicated that plant height had some positive effects by mechanical loosening of soil. Micronutrients also had significant role for increasing plant height in this treatment. Deshmukh and Wavhal [22] also stated that with the application of micronutrients like B and Zn, augmented in plant height occurred.

Table 3: Effects of different techniques on height of plants after tunnel removal and at full maturity stage

Treatments	Plant height when tunnel Removed (cm)	Plant height when full mature (cm)
Control	10.89 e	87.19 c
Mulch	28.87 c	87.52 c
Low tunnel	44.64 b	97.60 abc
Mulch + low tunnel	47.41 a	91.66 bc
Calcium carbide	26.78 cd	97.78 abc
Micronutrients	27.74 c	87.28 c
Mulch + CaC_2	24.63 d	99.05 ab
Mulch + Micronutrients	12.02 e	104.52 a

Table 4: Effects of different techniques on number of leaves and florets plant^{-1}

Treatments	Number of Leaves plant^{-1}	Number of florets plant^{-1}
Control	14.75 e	29.00 c
Mulch	18.50 a	34.93 ab
Low tunnel	16.72 bcd	35.58 a
Mulch + low tunnel	19.95 abc	32.83 abc
Calcium carbide	16.50 cd	30.08 bc
Micronutrients	17.16 abcd	36.31 a
Mulch + CaC_2	15.91 de	33.68 abc
Mulch + Micronutrients	18.33 ab	32.75 abc

Number of Leaves and Florets Plant^{-1}: There were not any significant differences among the treatments in case of number of leaves and florets plant^{-1} (Table 4). Data revealed that plants under black plastic mulch produced maximum number of leaves plant^{-1} compared to other treatments. These findings were also similar with the results of Karaye and Yakubu [23] that number of leaves plant^{-1} was increased, growth of weed was suppressed and yield was improved by suitable micro-climatic

Table 5: Effects of different techniques on spike thickness and floret diameter

Treatments	Spike thickness (mm)	Floret diameter (mm)
Control	5.30 b	28.92 e
Mulch	5.44 b	31.07 cde
Low tunnel	5.71 b	30.43 de
Mulch + low tunnel	5.43 b	33.29 c
Calcium carbide	5.03 b	32.63 cd
Micronutrients	6.42 a	40.58 a
Mulch + CaC_2	5.85 ab	30.55 de
Mulch + Micronutrients	5.49 b	36.83 b

Table 6: Effects of different techniques on consumer acceptability and earliness of tuberose

Treatments	Consumer acceptability	Earliness (Days)
Control	2.68 g	0.00 e
Mulch	5.31 e	15.36 c
Low tunnel	5.75 d	13.77 c
Mulch + low tunnel	6.00 c	27.48 a
Calcium carbide	5.00 f	7.36 d
Micronutrients	8.25 a	8.67 d
Mulch + CaC_2	5.25 e	21.87 b
Mulch + Micronutrients	8.00 b	27.15 a

conditions created by the mulching. Solaiman *et al*. [17] also found that black plastic mulch had significant effect on the number of leaves plant^{-1} of the crop. The maximum number of florets plant^{-1} was observed in treatment of micronutrients followed by low tunnel and mulch, respectively (Table 4). These results also favor the findings of Kumar and Arora [24] who stated that micronutrients revealed increased the number of leaves, number of florets and size of florets plant^{-1}. Salma *et al*. [25] also studied that micronutrients were best for promoting numbers and size of florets plant^{-1} with 0.2 % $FeSO_4$ + 0.2 % $ZnSO_4$ application.

Spike Thickness and Floret Diameter: Foliar application of micronutrients produced maximum spike thickness (Table 5) than any other treatment. To increase yield and advances the quality of crops, foliar feeding of micronutrients has become a renowned practice [26]. The minimum spike thickness was produced by plants in treatment of calcium carbide (CaC_2). These results were favored by Mahmood *et al*. [27] and studied in his experiment that CaC_2 application reduces the spike thickness. Floret diameter was also measured when plants were fully bloomed and micronutrients were also at peak in this character and produced maximum floret diameter (Table 5). These results were also in line with the observations of Kumar and Arora [24] that micronutrients increases the weight of spike by thickening the spike that ultimately increases the spike rigidity which reduced the breakage of the spike during strong winds or any other external factor and these micronutrients were also increases the floret diameter with large petal formation.

Consumer Acceptability and Earliness: According to the judges plants in treatment of micronutrients obtained maximum scores (Table 6) in the character of consumer acceptability followed by mulch with micronutrients. There was more attraction in the plants of micronutrients in respect of flower color, flower shape, plant height and stem thickness while control treatment got minimum scores from the judges due to less quality of floral characteristics. These findings were similar with the results of Kumar and Arora [24] that micronutrients increases the number of leaves and florets, weight of spike by thickening the spike, increases plant height, size of florets by increasing the floret diameter and all other quality characteristics. As a result of good quality characteristics consumer preferred to purchase the plant with good rates and at the end of the experiment earliness was calculated. Low tunnel with mulch was best for creating the earliness followed by mulch with micronutrients (Table 6). Low tunnel played a key role for creating the earliness by providing suitable micro climatic conditions for the crop growth and development. Ramakrishna *et al*. [16] also showed similar results and stated that plants in polyethylene and mulches generally grow vigorously [28,29], tall and reached early maturity by improving the micro environmental conditions inside the tunnel.

CONCLUSION

It was concluded from the experiment that micronutrients were best for producing improved growth (vegetative and reproductive) and flower quality characteristics and low tunnel with combination of mulch were ideal for creating the earliness in tuberose (*Polianthes tuberosa* L.) cv. double.

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