Growth, Flowering and Yield of Tuberose (Polianthes tuberosa L.) cv. Single as Influenced by Foliar Application of ZnSO₄ and CuSO₄

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Abstract

A field experiment on foliar application of ZnSO₄ and CuSO₄ on growth, flowering and yield of tuberose (Polianthes tuberosa L.) cv. Single was carried out at Horticultural Experimental Field, College of Agriculture, Central Agricultural University, Imphal during 2012-13. The result of the study revealed that increasing levels of ZnSO₄ upto 0.5% resulted in superior growth, flowering and yield of tuberose. Foliar application of ZnSO₄ @ 0.5% gave maximum number of leaves/plant, number of tillers per plant, plant height, number of spike/plant, spike length, rachis length, number of florets/spike, number of bulbs/clump, weight of bulbs/clump, diameter of the largest bulb, yield of spike/ha and yield of bulb/ha. Among different levels of CuSO₄ 0.25% CuSO₄ recorded significantly higher value for the growth, flowering and yield parameters. Interaction of different levels of ZnSO₄ and CuSO₄ recorded maximum value for growth, flowering and yield parameters.

Keywords
ZnSO₄, CuSO₄, Tuberose, Foliar application, Micronutrients.

Introduction

Tuberose (Polianthes tuberosa L.) cv. Single members of Amaryllidaceae family, native of Mexico is one of the most popular bulbous ornamental crop in India and abroad because of its delightful fragrance, attractive spike and high economic value. It has gained considerable popularity and widely grown for aesthetic, aromatic and commercial purposes. Its waxy white flowering spike with pleasant fragrance are in great demand for indoor decoration, garlands, bouquets, cut flower trade and extraction of oil. The single cultivar has a great economic potential in essential oil industry. The essential oil content is 0.08-0.11% which is extracted by solvent extraction method. In Manipur condition, production of tuberose is yet to be popularized because of non-availability of suitable agro techniques. Micronutrients play an important role in growth, flowering and yield of tuberose. Even though the work on major nutrients has been done in tuberose, the information on the use of micronutrients is lacking in Manipur. Hence the present studies was undertaken to find out the best level of ZnSO₄ and CuSO₄ and their combinations as foliar spray for optimum growth, flowering and maximizing yield of tuberose.
Materials and Methods

The experiment consisted of 9 treatment combinations comprising 3 levels of ZnSO₄ (0%, 0.5% and 1.0%) and 3 levels of CuSO₄ (0%, 0.25% and 0.5%). Each treatment was replicated thrice in a Factorial Randomised Block Design. The plot size was 1.5 x 1.8 m² with a planting distance of 30cm x 30cm. Uniform cultural operations were followed during the course of investigations. Bulbs were lifted at the end of each season. The data on vegetative parameters viz., plant height, number of leaves per plant and number of tillers per plant; flowering parameters like length of rachis, length of spike, number of spike per plant, number of florets per spike, days to flowering, duration of flowering and yield of spikes and bulb parameters viz., number of bulbs per clump, weight of the bulbs per clump, diameter of largest bulb, weight of largest bulb and yield of bulb were recorded.

Results and Discussion

The data presented in table 1 revealed that foliar application of ZnSO₄ and CuSO₄ had significant influence on growth, flowering and yield of tuberose. ZnSO₄ @ 0.5% produced significantly the maximum plant height (60.02 cm) followed by 1.0% ZnSO₄ (52.25 cm). The minimum plant height (50.08 cm) was observed in control (0% ZnSO₄). This might be due to the role of zinc in synthesis of tryptophan which is a precursor of auxin and is essential in nitrogen metabolism which stimulates the growth (Jat et al., 2007). The results were in agreement with Barman and Pal (1993) and Munikrishnappa et al., (2002) in tuberose. It was also clear from table 1 that lower dose of CuSO₄ upto 0.25% resulted the maximum number of tillers per plant (4.32) while minimum was recorded under control (3.23). This was in line with the findings of Barman and Pal (1993) in tuberose and Katiyar et al., (2005) in gladiolus and Khosa et al., (2011) in gerbera.

Among the different levels of ZnSO₄, 0.5% ZnSO₄ recorded the maximum number of tillers per plant (4.24). The lowest number of tillers per plant was observed under control (3.40). Similar observations were made by Barman and Pal (1993) and Munikrishnappa et al., (2002) in tuberose. It was also clear from table 1 that lower dose of CuSO₄ upto 0.25% resulted the maximum number of tillers per plant (4.32) while minimum was recorded under control (3.23). This was in line with the findings of Barman and Pal (1993) in tuberose and Katiyar et al., (2005) in gladiolus.

The number of leaves per plant of tuberose increased significantly with the increase in ZnSO₄ levels upto 0.5%. The maximum number of leaves per plant of tuberose was recorded with the application of 0.5 % ZnSO₄ (54.14) while the lowest number of leaves per plant was observed under control (47.21). The finding was in line with the results observed by Munikrishnappa et al., (2002) and Kumar et al., (2003) in tuberose. Foliar application of 0.25% CuSO₄ recorded the maximum number of leaves per plant of tuberose (53.67) as compared with 0.5% CuSO₄ and 0% CuSO₄. The finding was in conformity with that of Katiyar et al., (2005) in gladiolus and Khosa et al., (2011) in gerbera.

Among the different levels of ZnSO₄, 0.5% ZnSO₄ recorded the maximum number of tillers per plant (4.24). The lowest number of tillers per plant was observed under control (3.40). Similar observations were made by Barman and Pal (1993) and Munikrishnappa et al., (2002) in tuberose. It was also clear from table 1 that lower dose of CuSO₄ upto 0.25% resulted the maximum number of tillers per plant (4.32) while minimum was recorded under control (3.23). This was in line with the findings of Barman and Pal (1993) in tuberose and Katiyar et al., (2005) in gladiolus.

The number of days to flowering was significantly affected due to the varying levels of ZnSO₄. Earliest flowering was recorded when the plants were applied with 0.5% ZnSO₄ (65.38 days) while maximum number of days (73.77 days) to flowering was observed in the control treatment. The reason for early flowering may be due to the fact that zinc promotes flower setting and helps in proper development of flowers. It also helps in regulating auxin concentration in plants. These findings were in close agreement with and Rawia et al., (2010) in tuberose and Bala et al., (2007) and Reddy et al., (2009) in gladiolus. Among the different levels of
CuSO₄, 0.25% CuSO₄ recorded earliest flowering (66.08 days) which was significantly better than the rest of the treatments including control. This might be due to the reason that copper being an essential component in chlorophyll formation which help to catalyze several plant processes. Plants under control recorded the maximum days (75.03) for flowering. The finding was in favour with the observations of Bandyopadhyay et al., (1994) in marigold and Katiyar et al., (2005) in gladiolus.

The length of spike and length of rachis increased with the increasing level of ZnSO₄ upto 0.5%. The maximum spike length (99.69 cm) and rachis length (20.82 cm) was observed under treatment receiving 0.5% ZnSO₄ which was significantly higher than the rest of the treatments including control. ZnSO₄ @ 0% (control) recorded the minimum length of spike (91.17 cm) and minimum length of rachis (15.10 cm) of tuberose. The finding was found in line with that of Attoa (2002), Jauhari et al., (2003) and Kumar et al., (2003) in tuberose. Different levels of CuSO₄ also had a significant effect on the length of spike and length of rachis of tuberose. The longest length of spike (98.49 cm) and the length of rachis (20.35 cm) were observed under the treatment receiving 0.25% CuSO₄. Minimum length of spike (89.96 cm) and minimum length of rachis (14.47 cm) of tuberose was recorded under control (CuSO₄ @ 0%). These findings were in agreement with Bandyopadhyay et al., (1994) in marigold and Katiyar et al., (2005) in gladiolus.

The number of florets per spike increased with the increasing levels of ZnSO₄. The highest number of florets per spike (31.26) was recorded at 0.5% ZnSO₄. This increase in number of florets per spike could be attributed to increase in photosynthesis with enhanced carbohydrate fixation in plants which might have caused luxurious vegetative growth (Naik et al., 2009). Plants under control recorded minimum number of florets per spike (23.09). Similar results were obtained by Kumar et al., (2003) and Bala et al., (2007) in tuberose. The maximum number of florets per spike (30.31) was recorded with 0.25% CuSO₄. Minimum number of florets per spike (21.21) was recorded under control. Similar results were obtained by Bandyopadhyay et al., (1994) in marigold and Katiyar et al., (2005) in gladiolus.

Table 2 revealed that the number of spikes per plant increased with the increasing levels of ZnSO₄. The highest number of spikes per plant (3.68) was recorded under 0.5% ZnSO₄ while the lowest number of spikes per plant of tuberose (2.90) was recorded under control. Similar results were observed by Kumar et al., (2003) in tuberose, Sharma et al., (2004) in gladiolus and Nag et al., (2003) in marigold. The foliar application of 0.25% CuSO₄ recorded highest number of spikes per plant (3.53) which though on par with 0.5% CuSO₄. Plants under control recorded minimum number of spikes per plant (2.84).

The maximum duration of flowering (19.29 days) was recorded at 0.5% ZnSO₄ and was found superior to the rest of the treatments. ZnSO₄ @ 0% (Control) recorded minimum duration of flowering in tuberose (15.79 days) in the field. This might be due to beneficial effects of zinc on the physiological and other activities of the plant, thereby lengthening the duration. The findings were in agreement with that of Rawia et al., (2010) in tuberose. Different levels of CuSO₄ had significant effect on the duration of flowering in tuberose with the foliar application of 0.25% CuSO₄. The maximum duration of flowering was recorded by the treatment 0.25% CuSO₄ (19.62 days) which was significantly higher than the rest of the treatments while minimum duration of flowering (14.29 days) was recorded under control (0% CuSO₄). Copper is essential for many plant functions as it is
important to the formation of lignin in plant cell walls which contributes to the structural strength of the cells and the plant (Katiyar et al., 2005).

**Table.1** Effect of foliar application of ZnSO₄ and CuSO₄ on vegetative parameters of Tuberose cv. Single

| Treatment  | Plant height (cm) | Number of leaves/plant | Number of tillers/plant |
|------------|------------------|------------------------|-------------------------|
| Zn₁ (0%)   | 50.08            | 47.21                  | 3.40                    |
| Zn₂ (0.5%) | 60.02            | 54.14                  | 4.24                    |
| Zn₃ (1.0%) | 52.25            | 47.45                  | 3.44                    |
| S.Ed       | 0.22             | 0.31                   | 0.04                    |
| C.D.0.05   | 0.48             | 0.67                   | 0.10                    |

| Treatment  | Plant height (cm) | Number of leaves/plant | Number of tillers/plant |
|------------|------------------|------------------------|-------------------------|
| Cu₁ (0%)   | 50.09            | 45.49                  | 3.23                    |
| Cu₂ (0.25%)| 56.78            | 53.67                  | 4.32                    |
| Cu₃ (0.5%) | 55.50            | 49.65                  | 3.52                    |
| S.Ed       | 0.22             | 0.31                   | 0.04                    |
| C.D.0.05   | 0.48             | 0.67                   | 0.10                    |

**Table.2** Effect of foliar application of ZnSO₄ and CuSO₄ on floral parameters of Tuberose cv. Single

| Treatment  | Days taken to flowering | Length of spike (cm) | Length of rachis (cm) | Number of florets/spike | Number of spikes/plant | Duration of flowering | Yield of spikes (000/ha) |
|------------|-------------------------|----------------------|-----------------------|-------------------------|------------------------|-----------------------|--------------------------|
| Zn₁ (0%)   | 73.77                   | 91.97                | 15.10                 | 23.09                   | 2.90                   | 16.79                 | 150.90                   |
| Zn₂ (0.5%) | 65.38                   | 99.69                | 20.82                 | 31.26                   | 3.68                   | 19.29                 | 251.34                   |
| Zn₃ (1.0%) | 72.21                   | 91.54                | 15.54                 | 23.75                   | 3.00                   | 16.50                 | 195.15                   |
| S.Ed       | 0.61                    | 0.38                 | 0.26                  | 0.36                    | 0.01                   | 0.35                  | 2.68                     |
| C.D.0.05   | 1.30                    | 0.81                 | 0.56                  | 0.78                    | 0.02                   | 0.72                  | 5.68                     |

| Treatment  | Days taken to flowering | Length of spike (cm) | Length of rachis (cm) | Number of florets/spike | Number of spikes/plant | Duration of flowering | Yield of spikes (000/ha) |
|------------|-------------------------|----------------------|-----------------------|-------------------------|------------------------|-----------------------|--------------------------|
| Cu₁ (0%)   | 75.03                   | 89.96                | 14.47                 | 21.21                   | 2.84                   | 14.29                 | 167.17                   |
| Cu₂ (0.25%)| 66.08                   | 98.49                | 20.35                 | 30.31                   | 3.53                   | 19.62                 | 239.63                   |
| Cu₃ (0.5%) | 70.25                   | 94.13                | 16.63                 | 26.59                   | 3.23                   | 17.68                 | 190.59                   |
| S.Ed       | 0.61                    | 0.38                 | 0.26                  | 0.36                    | 0.01                   | 0.35                  | 2.68                     |
| C.D.0.05   | 1.30                    | 0.81                 | 0.56                  | 0.78                    | 0.02                   | 0.72                  | 5.68                     |

**Table.3** Effect of foliar application of ZnSO₄ and CuSO₄ on bulb parameters of Tuberose cv. Single

| Treatment  | Number of bulbs/clump | Weight of bulbs/clump (g) | Weight of largest bulb (g) | Diameter of largest bulb (cm) | Yield of bulbs (t/ha) |
|------------|-----------------------|---------------------------|---------------------------|-------------------------------|----------------------|
| Zn₁ (0%)   | 11.34                 | 91.57                     | 18.84                     | 2.97                          | 10.78                |
| Zn₂ (0.5%) | 16.16                 | 100.48                    | 20.27                     | 3.76                          | 11.40                |
| Zn₃ (1.0%) | 12.38                 | 93.89                     | 19.48                     | 3.03                          | 10.90                |
| S.Ed       | 0.35                  | 0.43                      | 0.32                      | 0.07                          | 0.42                 |
| C.D.0.05   | 0.74                  | 0.89                      | 0.67                      | 0.15                          | 0.09                 |

| Treatment  | Number of bulbs/clump | Weight of bulbs/clump (g) | Weight of largest bulb (g) | Diameter of largest bulb (cm) | Yield of bulbs (t/ha) |
|------------|-----------------------|---------------------------|---------------------------|-------------------------------|----------------------|
| Cu₁ (0%)   | 10.75                 | 89.63                     | 19.07                     | 2.79                          | 10.63                |
| Cu₂ (0.25%)| 15.62                 | 99.86                     | 20.10                     | 3.64                          | 11.42                |
| Cu₃ (0.5%) | 13.51                 | 96.31                     | 19.56                     | 3.27                          | 11.03                |
| S.Ed       | 0.35                  | 0.43                      | 0.32                      | 0.07                          | 0.42                 |
| C.D.0.05   | 0.74                  | 0.89                      | 0.67                      | 0.15                          | 0.09                 |
Table 4 Interaction effect of foliar application of ZnSO₄ and CuSO₄ on growth, flowering and yield of tuberose cv. Single

| Treatment | No. of tillers/plant | Days taken to flowering | No. of leaves/plant | Plant height (cm) | Length of spike (cm) | Length of rachis (cm) | No. of florets/spike | No. of spikes/plant | Duration of flowering | Yield of spikes (000/ha) | No. of bulbs/clump | Weight of bulbs/clump (g) | Weight of largest bulb (g) | Diamet er of largest bulb (g) | Yield of bulbs (t/ha) |
|-----------|----------------------|-------------------------|---------------------|-----------------|---------------------|---------------------|---------------------|---------------------|-----------------------|-------------------------|-----------------|------------------------|--------------------------|-----------------------------|------------------|
| Zn₁Cu₁    | 4.01                 | 78.28                   | 46.15               | 3.09            | 86.43               | 12.18               | 17.76               | 2.52                | 12.18                 | 113.71                  | 8.18            | 84.78                  | 18.18                    | 2.51                         | 10.21           |
| Zn₁Cu₂    | 4.01                 | 69.06                   | 52.46               | 4.01            | 97.09               | 18.58               | 28.39               | 3.17                | 18.56                 | 205.52                  | 15.31           | 97.77                  | 19.91                    | 3.42                         | 11.32           |
| Zn₁Cu₃    | 3.12                 | 73.96                   | 51.65               | 3.12            | 90.05               | 14.55               | 23.14               | 3.02                | 16.64                 | 135.52                  | 10.52           | 92.17                  | 18.45                    | 2.98                         | 10.81           |
| Zn₂Cu₁    | 3.45                 | 70.78                   | 55.74               | 3.45            | 96.12               | 17.32               | 26.78               | 3.39                | 17.28                 | 204.90                  | 14.62           | 96.38                  | 19.39                    | 3.36                         | 11.23           |
| Zn₂Cu₂    | 5.19                 | 60.08                   | 63.34               | 5.19            | 103.63              | 24.89               | 35.54               | 4.09                | 21.89                 | 309.75                  | 17.14           | 103.53                 | 20.81                    | 4.18                         | 11.52           |
| Zn₂Cu₃    | 4.06                 | 65.29                   | 60.98               | 4.06            | 99.34               | 20.27               | 31.47               | 3.57                | 18.73                 | 239.34                  | 16.73           | 101.10                 | 20.63                    | 3.75                         | 11.45           |
| Zn₃Cu₁    | 3.15                 | 76.03                   | 48.38               | 3.15            | 87.40               | 13.92               | 19.09               | 2.62                | 13.42                 | 182.91                  | 9.42            | 87.73                  | 18.42                    | 2.52                         | 10.46           |
| Zn₃Cu₂    | 3.78                 | 69.11                   | 54.51               | 3.78            | 94.75               | 17.60               | 27.02               | 3.34                | 18.42                 | 203.64                  | 14.42           | 98.29                  | 20.45                    | 3.32                         | 11.42           |
| Zn₃Cu₃    | 3.39                 | 71.49                   | 53.87               | 3.39            | 92.45               | 15.06               | 25.16               | 3.08                | 17.67                 | 198.92                  | 13.30           | 96.67                  | 19.58                    | 3.27                         | 10.83           |
| S.Ed      | 0.08                 | 1.06                    | 0.39                | 0.08            | 1.66                | 0.45                | 0.62                | 0.02                | 0.59                  | 4.64                    | 0.62            | 0.73                   | 0.54                     | 0.12                         | 0.73            |
| C.D.0.05  | 0.18                 | 2.26                    | 0.83                | 0.18            | 1.41                | NS                  | 1.34                | 0.04                | 1.26                  | 9.84                    | 1.29            | 1.54                   | NS                      | 0.26                         | NS              |
The data presented in table 2 revealed that increase in levels of ZnSO₄ significantly increased the yield of spikes/ha. Amongst all the treatments ZnSO₄ @ 0.5% recorded maximum yield of spikes/ha (251.33) which was significantly superior to rest of the treatments including control. The lowest yield of spikes/ha was observed under control (150.91). This might be due to influence of zinc on the synthesis of growth promoting substances and at the same time it monitors enzymatic activity within the plant which is ultimately reflected on the yield (Munikrishnappa et al., 2002; Jat et al., 2007). Treatment receiving CuSO₄ @ 0.25% recorded maximum yield of spikes/ha (239.63) which was significantly higher than the rest of the treatments. Lowest yield of spikes/ha was observed under control (167.17). Similar findings were observed by Bandhopadhyay et al., (1994) in marigold and Singh et al., (2012) in gladiolus.

The number of bulbs per clump of tuberose increased significantly with the increase in the levels of ZnSO₄. The maximum number of bulbs per clump (16.16) was recorded at 0.5% ZnSO₄ while minimum number of bulbs per clump (11.34) was observed under control (0% ZnSO₄). However, further increase in the dose of ZnSO₄ had no additional effect on bulb production. This might be due to the role of zinc that helps in translocation of constituents from one part to other and hence higher production of bulbs (Naik et al., 2009). Similar results were observed by Rawia et al., (2010) in tuberose and Khalifa et al., (2011) in iris. Foliar application of CuSO₄ @ 0.25% resulted in maximum weight of bulbs per clump (99.86) per clump which was significantly higher than the rest of the treatments. While the lowest weight of bulbs per clump (89.63) was recorded under control (0% CuSO₄). Similar results were observed by Katiyar et al., (2005) and Singh et al., (2012) in gladiolus.

The weight of the largest bulb and diameter of largest bulb of tuberose increased significantly with the increase in levels of ZnSO₄ upto 0.5%. The maximum weight of largest bulb was recorded at 0.5% ZnSO₄ (20.27g). While minimum weight of the largest bulb was observed under control (18.84g). The maximum diameter of largest bulb was observed with the treatment receiving 0.5% ZnSO₄ (3.76 cm). This might be due to the fact that ZnSO₄ increases the vegetative growth and thus leads to production of more food material, which in turn might have been utilized for better development of diameter (Jat et al., 2007). The result was in close agreement with the observation made by Rawia et al., (2010) in tuberose. Foliar application of CuSO₄ @ 0.25% recorded maximum weight of largest bulb (20.10g) and diameter of the largest bulb (3.64 cm) which was significantly higher than...
rest of the treatments including control. Minimum weight of the largest bulb (18.67g) and minimum diameter of the largest bulb (2.97 cm) were observed under control (CuSO₄ 0%). Similar results were observed by Katiyar et al., (2005) and Singh et al., (2012) in gladiolus.

Table 3 revealed that increase levels of ZnSO₄ significantly increased the yield of bulb/ha of tuberose. Amongst all the treatments, ZnSO₄ @ 0.5% recorded maximum yield of bulb (11.40 t/ha) which was significantly superior over rest of the treatments including control. The lowest yield of bulb (10.78 t/ha) was observed under control (ZnSO₄ @ 0%). This might be due to the fact that zinc plays a vital role in growth and development of plant because of its stimulatory and catalytic effect in various physiological and metabolic processes of plants (Muthumanickam, 1999). Similar findings were reported by Singh et al., (2012) in gladiolus. Among different levels of CuSO₄, 0.25% CuSO₄ recorded maximum yield of bulb (11.42 t/ha) which was significantly higher than the rest of the treatments including control. Lowest yield of bulb (10.63 t/ha) was observed under control (0% CuSO₄).

The difference in plant height due to interaction of different levels of ZnSO₄ and in CuSO₄ was significant (Table 4). The treatment combination Zn₂Cu₂ produced the maximum plant height (63.34 cm) while the minimum (46.15 cm) was recorded under control (Zn₁Cu₁). The interaction effect of the levels of ZnSO₄ and levels of CuSO₄ could significantly influence the number of leaves per plant of tuberose. The interaction of Zn₂Cu₂ recorded the maximum number of leaves per plant (58.47) and was significantly superior to other treatment combinations including control. The minimum number of leaves per plant was recorded under control (43.45). Interaction effect of different levels of ZnSO₄ and CuSO₄ on number of tillers per plant had significant influence on number of tillers per plant. The maximum number of tillers per plant was observed under Zn₂Cu₂ (5.19) while the minimum number of tillers per plant (3.09) was observed under control (Zn₁Cu₁). Table 4 showed that interaction effect of different levels of ZnSO₄ and CuSO₄ on tuberose had significant effect on the days taken to flowering. The combination of Zn₂Cu₂ (60.08) recorded the earliest days to flowering. Amongst all the treatment combinations, Zn₂Cu₂ (103.63 cm) resulted in longest spike length and longest rachis length (24.89 cm) which was significantly higher than other treatments including control. Shortest spike length (86.43 cm) and shortest rachis length (12.18 cm) was observed under Zn₁Cu₁ (control). The interaction effect of different levels of ZnSO₄ and CuSO₄ was found significant on the number of florets per spike. Amongst all treatment combinations Zn₂Cu₂ (35.54) gave the maximum number of florets per spike which was significantly higher than other treatment combinations. Minimum number of florets per spike (17.76) was recorded under Zn₁Cu₁ (control). The difference due to interaction effect was significant. Amongst all the treatment combinations Zn₂Cu₂ (4.09) resulted in the maximum number of spikes per plant. Plants under Zn₁Cu₁ recorded the minimum number of spikes per plant (2.52).

Interaction effect of foliar application of CuSO₄ and ZnSO₄ had significant influence on the duration of flowering in tuberose. Amongst all treatment combinations Zn₂Cu₂ resulted in the longest duration of flowering (21.89 days) which was significantly higher than the rest of the treatments including control. Plants under control (Zn₁Cu₁) recorded the minimum duration of flowering (12.18 days). The interaction effect of foliar application of ZnSO₄ and CuSO₄ was found significant on the yield of spikes/ha. Amongst
all the treatments, maximum yield of spikes/ha of tuberose was recorded with the treatment combinations Zn₂Cu₂ (309.75) while the minimum yield (113.71) of spikes/ha was recorded under control (Zn₁Cu₁). The difference due to interaction effect was significant.

Maximum number of bulbs per clump was recorded under Zn₂Cu₂ (17.14) while Zn₁Cu₁ recorded minimum number of bulbs per clump (8.18). Interaction effect of foliar application of ZnSO₄ and CuSO₄ had significant influence on the weight of bulbs per clump (g). The maximum weight of bulbs per clump (103.53g) was recorded by Zn₂Cu₂ which was significantly higher than the rest of the treatments including control. The minimum weight (84.78g) was recorded under control (Zn₁Cu₁). Interaction of different levels of ZnSO₄ and CuSO₄ had no significant effect on weight of the largest bulb.

The interaction of different levels of ZnSO₄ and CuSO₄ had a significant influence on diameter of the largest bulb. The maximum diameter of largest bulb (4.18cm) was recorded by Zn₂Cu₂ which was significantly superior to the rest of the treatments including control. The minimum diameter (2.51cm) was recorded under control. Interaction of different levels of ZnSO₄ and CuSO₄ had no significant effect on yield of bulb (t/ha).

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How to cite this article:

Renuka Devi, S., Rocky Thokchom and Singh, U.C. 2017. Growth, Flowering and Yield of Tuberose (Polianthes tuberosa L.) cv. Single as Influenced by Foliar Application of ZnSO₄ and CuSO₄. Int.J.Curr.Microbiol.App.Sci. 6(10): 735-743.

doi: https://doi.org/10.20546/ijcmas.2017.610.090