**Original Research Article**

**Effect of spacing and micronutrients on growth and flowering parameters in Annual Chrysanthemum *cv*. Bijli (*Chrysanthemum coronarium* L.)**

**Abstract**

An experiment was conducted at Farmer’s field, Hagarga village, Kalaburagi district during 2023-24 on effect of spacing and micronutrients on growth and flowering parameters in annual chrysanthemum *cv*. Bijli (*Chrysanthemum coronarium* L.). The experiment consists of two factors *i.e*., four spacings (30 x 15, 30 x 30, 40 x 15 and 40 x 30 cm) and four micronutrient application (Micronutrient mixture @ 0.2, 0.3, 0.4 and 0.5 %) in factorial Randomized Block Design with three replications. The results revealed that significantly maximum plant height (98.05 cm), minimum days to first flower bud initiation and 50 per cent flowering (41.50 and 66.23 days), maximum flower yield per plot and per hectare (8.05 kg and 14.91 t) recorded significantly highest in S1. Between different concentration of micronutrient applications, M4 registered significantly highest plant height (102.07 cm), minimum days to first flower bud initiation (44.00 days) and 50 per cent flowering (67.78 days), maximum flower yield per plot (5.89 kg) and per hectare (12.08 t). Hence, the results of present investigation revealed that, planting with closure spacing (S1) and 0.5 percent micronutrient mixture (M4) were found to be superior.

**Keywords:** Annual chrysanthemum, flowering, micronutrient application, Spacing.

**Introduction**

Annual chrysanthemum also called as Garland chrysanthemum, botanically known as *Chrysanthemum coronarium* L., is an annual under the chrysanthemum group of flowers. It is different from pluriannual or florist chrysanthemum in many aspects. It is relatively short duration crop and less photosensitive.

It is more hardy, vigorous and grows taller. Its flowers are in various shades of yellow, white, having single or double forms. They are hermaphrodite. The plant is self-fertile and seed propagated. It is typically used for bedding in landscape gardening as well as garland making. Typically, flowers are used to create garlands, veni, hair adornments and floral arrangements for religious and social gatherings. The taller varieties of annual chrysanthemum are great border plants, whereas, the shorter varieties can be grown as edging plants. In addition, it is utilized as a potted plant and blooms are prepared for bouquets, vases and flower decoration.

Growth and flower production can be affected by spacing. It is opined by various researchers that closer spacing accommodates more number of plants but deteriorates the quality of flowers and reduces yield per plant. Wider planting on the other hand could lead to improper use of natural resources including soil, fertilizers and water. So, optimum spacing is required to produce better quality flowers as well as higher yield.

Zinc, iron, boron and manganese are needed in small amount for crop production and therefore, classified as micronutrients. Zinc is an important component of various enzymes that are responsible for driving many metabolic reactions in all crops. Plants need iron for chlorophyll formation and photosynthesis. Manganese (Mn) is an important micronutrient for plant growth and development and sustains metabolic roles within different plant cell compartments. The primary role of boron in plants is to improve Ca metabolism and helps the absorption of nitrogen.

**Material and Methods**

The field experiment was conducted with four spacing (S1- 30 x 15 cm, S2- 30 x 30 cm, S3- 40 x 15 cm, S4- 40 x 30 cm) and four different concentrations of micronutrients applications *viz*., M1- Micronutrient mixture @ 0.2%, M2-Micronutrient mixture @ 0.3%, M3-Micronutrient mixture @ 0.4% and M4-Micronutrient mixture @ 0.5% during *Rabi* 2023-24 at Farmer’s field, Hagarga village, Kalaburagi. Micronutrient mixture sprayed at 20 and 40 days after transplanting. The flowers were harvested when it reached full bloom stage for all the treatments. The flowers harvested from field experiment was used to assess the flower reproductive yield and quality parameters using factorial randomized block design (FRBD) with three replications to know the effect of spacing and micronutrient application in annual chrysanthemum.

**Observations**

The observations were recorded for plant height (cm), days to first flower bud initiation (days), days to 50 per cent flowering (days), yield per plot (kg) and yield per hectare (t). The data pertaining to several characteristics of flower quality were statistically analysed using the methodology outlined by Gomez and Gomez (1984).

**Results and Discussion**

The results showed that spacings and micronutrient applications had shown significance difference for plant height (cm), days to first flower bud initiation (days), days to 50 per cent flowering (days), yield per plot (kg) and yield per hectare (t). But, interactions had shown a non significance difference.

The closure spacing (S1) recorded significantly maximum plant height (98.05 cm) compared S4 spacing (91.90 cm). Among different micronutrient application M4 (Micronutrient mixture @ 0.5%) recorded significantly highest plant height (102.07 cm) compared to M1 (87.75 cm) (Table 1). This might be because This might be due to the higher density of plants which can reduce light penetration within the crop stand, causing plants to elongate their main stem in order to receive sufficient light for photosynthesis and enhanced availability of essential micro nutrients that are crucial for plant growth and development especially Zn plays an important role which stimulated the plant height and helps in synthesis of tryptophan as precursor of auxin. The similar results were demonstrated through the experiments conducted by Vasudeva (2007) in rose, Nagaraja (2013), Naik (2019) in marigold and Patel (2021) in chrysanthemum.

The closer spacing (S1) recorded significantly minimum days to first flower bud initiation (41.50 days) compared to S4 spacing (50.10 days). Among micronutrient applications, M4 (Micronutrient mixture @ 0.5%) recorded significantly minimum days to first flower bud initiation (44.00 days) compared M1 spacing (47.50 days) (Table 1). Due to more competition among the plants for nutrients, soil moisture, sunlight, *etc*., the plants growing in closer spacing produced less vegetative growth and tried to complete their reproductive stage earlier. These findings are supported by Dorajeerao *et al*. (2012) in annual chrysanthemum and Naik (2019) in marigold. Additionally, iron is essential for chlorophyll production and provides the energy necessary for flower bud development, as observed by Chopde *et al*. (2016) and Vanlalruati *et al*. (2019).

The closer spacing (S1) recorded significantly minimum days to 50 per cent flowering (66.23 days) compared to S4 spacing (74.45 days). Among micronutrient applications, M4 (Micronutrient mixture @ 0.5%) recorded significantly minimum days to 50 per cent flowering (67.78 days) compared M1  (72.73 days) (Table 1). Wider spaced plants, remained in vegetative phase for long on account of lesser competition from the adjacent plants for space and light, thus delayed flowering.. These findings are supported by Dorajeerao *et al*. (2012) in annual chrysanthemum. Additionally, Iron is vital for chlorophyll production, which supports the energy needs for flower bud development. Boron plays a direct role in reproductive processes by aiding in cell wall formation, pollen tube growth, and nutrient transport, as observed by Choudhary *et al.* (2016) and Patel (2021).

The closure spacing (S1) recorded significantly maximum flower yield per plot (8.05 kg) than S4 (3.78 kg). Among different micronutrient application, M4 treatment observed significantly maximum flower yield per plot (5.89 kg) than the treatment M1 (5.45 kg). This may be due to more plants per unit area in closer spacing and this got decreased with plant population per unit area in wider spacing. Similar results were also reported by Dorajeerao *et al.* (2012) in annual chrysanthemum. Optimal levels of boron greatly enhanced flowering by influencing reproductive phase directly. Boron aids in cell division, fortifies cell walls, and improves nutrient transport, all of which are essential for the development and maturation of a greater number of flower buds. A similar results found in Vasudeva (2007) in rose and Patel (2021) in chrysanthemum.

The closure spacing (S1) recorded significantly maximum flower yield per hectare (14.91 t) than S4 (9.01 t). Among different micronutrient application, M4 treatment observed significantly maximum flower yield per hectare (12.08 t) than the treatment M1 (11.20 t). This may be the result of less number of plants per unit area with wider spacing or more number of plants per unit area with closer spacing. Similar findings were also made by Amit (2004) and Dorajeerao *et al.* (2012) in annual chrysanthemum and Naik (2019) in marigold. Boron greatly enhances flowering by influencing reproductive phase directly when applied at optimal levels. Boron aids in cell division, fortifies cell walls, and improves nutrient transport, all of which are essential for the development and maturation of a greater number of flower buds. A similar results found in Bhute *et al*. (2017) and Bishnoi *et al*. (2017)

**Table 1. Effect of spacing and micronutrient application on growth and flowering**

 **parameters in annual chrysanthemum.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatments** | **Plant height (cm)** | **Days to first flower bud initiation** | **Days to 50 per cent flowering** | **Yield per plot (kg)** | **Yield per hectare (t)** |
| **Spacing** |
| **S1** | 98.05 | 41.50 | 66.23 | 8.05 | 14.91 |
| **S2** | 92.28 | 47.10 | 71.42 | 4.8 | 10.66 |
| **S3** | 95.43 | 43.80 | 68.53 | 5.98 | 11.86 |
| **S4** | 91.90 | 50.10 | 74.45 | 3.78 | 9.01 |
| **S.Em.±** | 5.05 | 2.62 | 3.56 | 0.32 | 0.57 |
| **CD @5%** | 14.59 | 7.56 | 10.30 | 0.93 | 1.66 |
| **Micronutrient mixture** |
| **M1** | 87.75 | 47.50 | 72.73 | 5.45 | 11.20 |
| **M2** | 90.57 | 46.00 | 70.48 | 5.56 | 11.42 |
| **M3** | 97.28 | 45.00 | 69.62 | 5.71 | 11.73 |
| **M4** | 102.07 | 44.00 | 67.78 | 5.89 | 12.08 |
| **S.Em.±** | 5.07 | 2.65 | 3.60 | 0.35 | 0.60 |
| **CD @5%** | 14.61 | 7.60 | 10.36 | 0.96 | 1.70 |

**Factor 1 : Spacing (S) Factor 2 : Micronutrients (M)**

**S1** : 30 × 15 cm **M1** : Micronutrient mixture (0.2%)

**S2** : 30 × 30 cm **M2** : Micronutrient mixture (0.3%)

**S3** : 40 × 15 cm **M3** : Micronutrient mixture (0.4%)

**S4** : 40 × 30 cm **M4** : Micronutrient mixture (0.5%)

**Table 2. Interaction effect between spacing and micronutrient application on growth and flowering parameters in annual chrysanthemum**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatment** | **Plant height (cm)** | **Days to first flower bud initiation** | **Days to 50 per cent flowering** | **Yield per plot (kg)** | **Yield per hectare (t)** |
| **Spacing x Micronutrient mixture** |
| **S1M1** | 93.13 | 42.47 | 68.60 | 7.73 | 14.32 |
| **S1M2** | 93.40 | 42.30 | 67.23 | 7.87 | 14.58 |
| **S1M3** | 100.67 | 41.50 | 65.57 | 8.14 | 15.07 |
| **S1M4** | 105.00 | 39.60 | 63.50 | 8.46 | 15.67 |
| **S2M1** | 85.80 | 49.07 | 74.07 | 4.67 | 10.37 |
| **S2M2** | 88.53 | 47.20 | 72.63 | 4.73 | 10.50 |
| **S2M3** | 94.47 | 46.43 | 70.20 | 4.83 | 10.73 |
| **S2M4** | 100.33 | 45.67 | 68.77 | 4.97 | 11.03 |
| **S3M1** | 88.33 | 45.10 | 70.93 | 5.75 | 11.40 |
| **S3M2** | 91.53 | 44.10 | 66.30 | 5.89 | 11.69 |
| **S3M3** | 98.80 | 43.40 | 69.00 | 6.06 | 12.03 |
| **S3M4** | 103.07 | 42.63 | 67.87 | 6.20 | 12.30 |
| **S4M1** | 83.73 | 53.40 | 77.33 | 3.65 | 8.70 |
| **S4M2** | 88.80 | 50.33 | 75.76 | 3.74 | 8.90 |
| **S4M3** | 95.20 | 48.67 | 73.70 | 3.82 | 9.09 |
| **S4M4** | 99.86 | 48.07 | 71.00 | 3.92 | 9.33 |
| **S.Em.±** | 3.37 | 1.74 | 2.38 | 0.21 | 0.38 |
| **CD @ 5 %** | NS | NS | NS | NS | NS |

**Factor 1 : Spacing (S) Factor 2 : Micronutrients (M)**

**S1** : 30 × 15 cm **M1** : Micronutrient mixture (0.2%)

**S2** : 30 × 30 cm **M2** : Micronutrient mixture (0.3%)

**S3** : 40 × 15 cm **M3** : Micronutrient mixture (0.4%)

**S4** : 40 × 30 cm **M4** : Micronutrient mixture (0.5%)

**Fig. 1. Plant height, days to first flower bud initiation and 50 percent flowering as influenced by spacing and micronutrients in annual chrysanthemum *cv*. Bijli.**

**Fig. 2. Yield per plot and per hectare as influenced by spacing and micronutrients in annual chrysanthemum *cv*. Bijli.**

**Conclusion**

From the study it can be concluded that closer spacing (30 x 15 cm) was found superior for all the growth and flowering parameters *viz*., plant height, number of days to first flower bud initiation and 50 percent flowering, flower yield per plot and per hectare than other spacing. Among different micronutrient application, M4 (Micronutrient mixture @ 0.5%) was found superior for all the growth and flowering parameters *viz*., plant height, number of days to first flower bud initiation and 50 percent flowering, flower yield per plot and per hectare.

**References**

Amit, D., 2004, Effect of plant spacing and nitrogen on growth, flowering and yield of annual chrysanthemum cv. local white. *Orissa J. Hortic*., 32(2): 55-56.

Bhute, P. N., Panchbhai, D. M., Raut, V. U., Neha Chopde, N. C. and Hemlata Khobragade, H. K., 2017, Studies on flower production in annual chrysanthemum in response to iron and zinc. *Plant Arch*., 17(2): 1017-1019.

Bishnoi, S., Polara, N. and Regar, A., 2017, Response of micro-nutrients on flowering, yield, quality and xanthophyll yield in African marigold (*Tagetes erecta* Linn.). *Biosci. Trends,* 10(2): 626-628.

Chopde, N., Borse, G. H., Kuchanwar, O. and Ghodke, A. T., 2016, Effect of zinc sulphate and ferrous sulphate on growth and flowering of annual chrysanthemum. *Plant* *Arch*., 16(2): 594-596.

Choudhary, A., Mishra, A., Bola, P. K., Moond, S. K., & Dhayal, M., 2016, Effect of foliar application of zinc and salicylic acid on growth, flowering and chemical constitute of African marigold cv. Pusa Narangi Gainda (*Targets erecta* L.). *J. Appl. Nat. Sci*., 8(3): 1467-1470.

Dorajeerao, A. V. D., Mokashi, A. N., Patil, V. S., Venugopal, K., Lingaraju, S. and Koti, R. V., 2012, Effect of plant spacing on yield and quality of garland chrysanthemum (*Chrysanthemum coronarium* L.). *Karnataka J. Agric. Sci.*, 25(2): 25-30.

Gomez K A and Gomez A A, 1984, Statistical procedures for agricultural research (2nd ed.), John wiley and sons, New York., 680.

Karavadia B N and Dhaduk B K, 2002, Effect of spacing and nitrogen on annual chrysanthemum (*Chrysanthemum coronarium*) Cv. Local White. *Journal of Ornamental Horticulture*, 5(1): 65-66.

Nagaraja, C. K., 2013, Effect of spacing and nutrition on growth and yield of annual chrysanthemum (*Chrysanthemum coronarium* L.). *M.Sc. (Agri.) Thesis*, KRC College of Horticulture, Arabhavi (Univ. Hortic. Sci., Bagalkot).

Naik, P. V., Seetharamu, G. K., Manjunath, N., Mohan Kumar, T. L. and Jogi, M. Y., 2019, Standardization of spacing and fertigation in marigold genotypes for northern dry zone of Karnataka. *Int. J. Chem. Stud.*, 7(6): 4003-4007.

Patel, D. K., 2021, Response of plant growth regulators and multi micronutrient on growth, yield and quality of chrysanthemum cv. Ratlam selection. *Int. J. Chem. Stud*., 9(2): 911-916.

Vanlalruati, S. S., Anand, Prativa. and Kumar, Gunjeet., 2019, Effect of micronutrients (Fe and Zn) on flowering and yield attributes of chrysanthemum (*Chrysanthemum morifolium*) cv. Mayur 5. *Indian J. Agric. Sci*., 89(8): 1282-1286.

Vasudeva, P. N., 2007, Effect of micronutrients on growth, yield and quality of rose (*Rosa hybrida*) under greenhouse. *Eco. Env. & Cons*., 17(1): 129-135.