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Effect of Fertigation Intervals on Plant Growth and Flower Yield of Multiflora Chrysanthemum (*Chrysanthemum morifolium)* cv. Branfountain Purple

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study was conducted in the Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj (UP) from October 2021- March 2022 to investigate the Effect of Fertigation Intervals on Plant Growth and Flower Yield of Multiflora Chrysanthemum (*Chrysanthemum morifolium)* cv. Branfountain Purple*.* The experiment was laid out in RBD with nine treatments which were replicated thrice. The results revealed that treatment T9 (19:19:19 NPK/m^2(4.6 g) @ 8 days interval)) + foliage spray of 0.2% EDTA Chelated micronutrient mixture) – performed the best in terms of plant height(cm) (21), number of branches (53), plant spread (cm) (27), Number of leaves (403), number of flowers per plant (75), chlorophyll content of leaves (SPAD value) (31.9), days to first flowering (days) (130), days 50% flowering (days) (143), flowering duration (days) (185), flower diameter (cm) (4.0), individual flower weight (g) (10), flower yield per plant (g/plant) (0.78). Therefore, the treatment T9 (T5+ foliage spray of 0.2% EDTA Chelated micronutrient mixture) was the best when compared to other treatments. Overall results revealed that the application of fertilizer through fertigation as T9 (19:19:19 NPK/m^2 (4.6 g) @ 8 days interval)) + foliage spray of 0.2% EDTA Chelated micronutrient mixture) proved to be better for different growth and flower yield of multiflora chrysanthemum.

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1. INTRODUCTION

"Chrysanthemum (*Chrysanthemum morifolium*) is one of the most important flower crops grown commercially in India for cut and loose flowers and is also used for garden display. It is commonly known as Guldaudi, Autumn Queen or Queen of the East" [1]. It belongs to the family Asteraceae. It is native to Northern Hemisphere. Chrysanthemum is popular flower meaning Chryos – golden, anthos – flower, a leading flower crop grown in many parts of the world, chiefly Europe and Asia with a few in other areas. It is one of the most beautiful flowering plant referred to as "Queen of the East" and "Autumn flower" [2-8]. "Its commercial cultivation is being done in states viz., Maharashtra, Rajasthan, Madhya Pradesh and Bihar and in places viz., Delhi, Kolkata, Lucknow, Kanpur and Allahabad mainly for the sake of decoration and participating in flower shows, with the help of pot grown plants [9-15]. Chrysanthemums are mainly classified under two categories: Large flowered (standard type) and small flowered (spray type)" [16]. "Large flowered chrysanthemums which produce long, sturdy stems and good keeping quality are further classified into 13 classes which make it suitable for flower arrangement, cut flower production and as potted flowering plant for exhibition and decoration [17-20]. The extra-large bloomed cultivars are used for exhibition value, bouquets, vase etc, whereas small flowered are mostly grown for loose flower and are classified into 10 classes [21,22]. The standard type flowers fetch higher prices though their share in export market is less but spray types have smaller flower size and have major share in the world market. In International cut flower trade, chrysanthemum ranks next to rose" [23].

"Fertigation is a new concept, adapted in several parts of the world, in horticulture crops. Fertigation which combines irrigation with fertilizer application is well recognized as the most effective and convenient means of maintaining optimum fertility level and water supply according to the specific requirements of the crop and soil resulting in higher yield and better quality" [24-28].

For various ornamental flower crops, foliar sprays was found more economically than soil application and combination sprays of micronutrients have been successfully resorted. The quality of chrysanthemum flowers is influenced by application of micronutrients and optimising the dose and chosing right method of application will enhance the flower production and quality [29]. The demand for increasing flower production will require clear cut information on how the micronutrients have effect on crop growth.

2. MATERIALS AND METHODS

The details of the various materials used and methods adopted to lay out the experiment are presented below:

2.1 Experimental Site

The experiment was carried out at, Horticulture Research Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) India. The area of Allahabad district comes under subtropical belt in the South East of Uttar Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46℃ – 48℃ and seldom falls as low as 4℃ – 5℃. The relative humidity ranged between 20-94%. The average rainfall in this area is around 1013.4mm annually. However, occasional precipitation is also not uncommon during winter months.

2.2 Experimental Details

The length of polybag is 6 inches and weight is 2 kg and N, P, and K is 19 kg, 19 kg and 19 kg/ ha-1, respectively. The experiment was laid out in randomized block design with three replications consisting of nine treatment combinations. Some treatments are comprised of organic manures with biofertilizers and different quantity levels of inorganic fertilizers. The spacing between rows and coloumns in the plot was 60 cm×60 cm. Statistical analysis of variance was performed on the data collected throughout the experiment. The observation was recorded for plant height (cm), number of branches per plant, plant spread (cm), number of leaves per plant, chlorophyll content, days to first flowering (days), days 50% flowering(days), flowering duration (days), flower diameter (cm), number of flower per plant, individual flower weight (g), flower yield per plant (g/plant), economics were analyzed statistically. The significance of the treatments was determined using the 'F' test at a level of significance of 5%.

Table 1. Treatment details

Treatment symbol	Treatment Combination
T_1	Control
T_2	19:19:19 NPK/m^2(1.2g @ 2 days interval)
T_3	19:19:19 NPK/m^2(2.33g @ 4 days interval)
T_4	19:19:19 NPK/m^2(3.5g @ 6 days interval)
T_5	19:19:19 NPK/m^2(4.6g @ 8 days interval)
T_6	T_2+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture
T_7	T_3+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture
T_8	T_4+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture
T_9	T_5+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

The data on growth parameters in different treatment combinations were recorded (Table 2).

3.1.1 Plant height

Maximum plant height (21.00 cm) was recorded in treatment T_9 (T_5+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture) and minimum plant height (16.00 cm) was obtained with treatment T_2 (19:19:19 NPK/m^2 (1.2 g @ alternate days interval)), T_3 (19:19:19 NPK/m^2 (2.33 g @ 4 days interval)) and T_4 (19:19:19 NPK/m^2 (3.5 g @ 6 days interval)). It might be due to nitrogen which is a constituent of protein and nucleic acid, which is helpful in plant growth and also promotes rapid growth.

3.1.2 Number of branches

The Maximum number of branches (53.00) was recorded in treatment T_9 (T5+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture) and minimum number of branches (42.00) was obtained with treatment T_2 (19:19:19 NPK/m^2 (1.2 g @ alternate days interval)). An increase in the number of branches per plant may be due to split application of fertilizers which increases growth and quality as observed with the present investigation, are in close conformity with the findings of [30,16] in Rose.

3.1.3 Number of leaves

Maximum number of leaves per plant (403) was recorded in treatment T_9 (T_5+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture) and minimum number of leaves per plant (215) was obtained with treatment T_2 (19:19:19 NPK/m^2 (1.2 g @ alternate days interval)). An increase in number of leaves per plant could be because of optimum nutrients provided to plants, which might have accelerated rate of photosynthesis thereby enhancing the vegetative growth of plants, as reported by Parya et al. [31] in golden rod.

3.1.4 Plant spread

Maximum plant spread (27.00 cm) was recorded in treatment T_9 (T_5+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture) and minimum plant spread (22.00 cm) was obtained with treatment T_2 (19:19:19 NPK/m^2 (1.2 g @ alternate days interval)). An increase in plant spread may be due to potassium which enhances the synthesis and translocation of carbohydrate. “Potassium has also been reported to be involved in the synthesis of peptide bond, and protein and carbohydrate metabolism, and also participates in rapid cell division and differentiation” [32].

3.2 Flower Parameters

3.2.1 Days to first flowering

The days to first flower bud initiation (days) was found to be minimum (130 days) in the treatment T_9 (T5+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture). Maximum days to first flower bud initiation (days) (140 days) was obtained in the treatment T_2 (19:19:19 NPK/m^2 (1.2 g @ alternate days interval)). The probable reason for early first flower bud initiation (days) may be contributed by meristematic activity of metabolites from vegetative growth of plants. Nitrogen and Phosphorus also resulted in maximum increase in nutrient uptake and stimulates blooming resulting in early flower bud development. Similar result was reported by Noorul et al. [33] in Gerbera.

3.2.2 Days to 50% flowering

The Days taken to 50% flowering (days) was found to be minimum (143) in the treatment T_2 (19:19:19 NPK/m^2 (1.2 g @ alternate days

interval)) and T_3 (19:19:19 NPK/m^2 (2.33 g @ 4 days interval)). Maximum Days taken to 50% flowering (152) was obtained in the treatment T_9 (T_5+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture). The Days taken to 50% flowering (days) was found to be maximum because the potassium dissolves in the soil water is taken up by the plant roots and the exchang eable K is released into the soil solution to maintain equilibrium between the two forms. "Potassium has also been reported to be involved in the synthesis of peptide bond, and protein and carbohydrate metabolism, and also participates in rapid cell division and differentiation" [32].

3.2.3 Flower duration

The duration of flower (days) was found to be minimum (55) in the treatment T_9 (T5+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture). Maximum duration of flower (days) (70) was obtained in the treatment T_2 (19:19:19 NPK/m^2 (1.2 g @ alternate days interval)). The duration of flower (days) was found to be minimum due to Potassium which is a major osmotically active component in plant cells contributing to cell turgor and enhancing the capacity of plant cell to retain water and nutrients. Nitrogen and Phosphorus also resulted in maximum increase in nutrient uptake and stimulates blooming resulting in early duration of flower (days).

3.2.4 Flower diameter

The flower diameter (cm) was found to be minimum (3.2 cm) in the treatment T_2 (19:19:19 NPK/m^2 (1.2 g @ alternate days interval)). And maximum flower diameter (4.0 cm) was obtained in the treatment T_9 (T_5+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture). "Maximum flowers diameter may be due to the high level of potassium which had pronounced effect on flower diameter among the macro nutrients. Balanced dose of nitrogen, phosphorus and potassium seemed to have increased the vegetative growth favorable for the synthesis of peptide bond, protein and carbohydrate metabolism that are essential for flower development. High potassium with appropriate dose of nitrogen and phosphorus seemed to have increased the number of flowers bud diameter in gerbera" [34].

3.3 Yield Parameters

Maximum number of flowers per plant (75) T_9 (T5+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture) was recorded in treatment and minimum number of flowers per plant (42) was obtained with treatment T_2 (19:19:19 NPK/m^2 (1.2 g @ alternate days interval)).

"High potassium with appropriate dose of nitrogen and phosphorus seemed to have increased the number of flowers per plant in gerbera" [34]. Maximum flower weight (10 g) T_9 (T5+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture) was recorded in treatment and minimum weight of single flower bud (5 g) was obtained with treatment T_2 (19:19:19 NPK/m^2(1.2 g @ alternate days interval)). "The reason for flower weight is due to the fact that the amount of applied nitrogen significantly increased the growth parameter like number of branches, plant height which have synthesized more plant metabolites and ultimately led to increased weight of single flower bud" [35].

3.3.1 Flower yield per plant

The flower yield per plant was found to be maximum (58.5 g/plant) in the treatment T_9 (T5+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture). The flower yield per plant was found to be minimum (7.98 g/plant) in the treatment T_2 (19:19:19 NPK/m^2 (1.2 g @ alternate days interval)). The reason for maximum number of flower is due to the fact that the amount of applied nitrogen significantly increased the growth parameter like number of branches, plant height which have synthesized more plant metabolites and ultimately led to increased number of flowers [35-42].

3.3.2 Flower weight

Maximum flower weight (10 g was recorded in treatment T_9 (T5+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture), T_8 (T_4+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture), T_7 (T_3+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture) and minimum weight of flower bud (5 g) was obtained with treatment T_2 (19:19:19 NPK/m^2 (1.2 g @ alternate days interval)). "The reason for flower weight is due to the fact that the amount of applied nitrogen significantly increased the growth parameter like number of branches, plant height which have synthesized more plant metabolites and ultimately led to increased weight of single flower bud" [43] in Chrysanthemum.

Table 2. Effect of fertigation on growth traits of chrysanthemum

Treatments	Plant height (cm)	No. of branches	Plant spread (cm)	No. of leaves/ plant	Days to First Flowering (days)	Day to 50% Flowering (days)	Flowering Duration (days)
T_1	18	47	25	287	136	148	61
T_2	16	42	22	215	140	152	70
T_3	16	44	23	233	140	152	65
T_4	16	45	23	239	139	151	60
T_5	17	47	24	247	138	149	58
T_6	18	48	26	340	135	147	59
T_7	19	50	26	351	134	147	58
T_8	19	51	26	388	132	145	57
T_9	21	53	27	403	130	143	55
CD (5%)	**1.58**	**4.20**	**25**	**18.33**	**4.01**	**5.46**	**4.04**
CV%	**5.14**	**5.11**	**22**	**3.53**	**1.70**	**2.13**	**3.87**

Table 3. Effect of fertigation on yield traits of chrysanthemum

Treatments	Flower Diameter (cm)	Flower weight (g)	No. of Flower/ Plant	Flower Yield (g/plant)	Chloropyll SPAD- 502
T_1	3.5	9	62	33.48	24.1
T_2	3.2	5	42	7.98	20.1
T_3	3.2	6	46	11.96	23.3
T_4	3.4	7	48	15.36	24.9
T_5	3.5	8	54	22.14	26.7
T_6	3.6	9	66	37.62	28.3
T_7	3.5	10	68	44.2	29.4
T_8	3.7	10	71	48.99	30.3
T_9	4.0	10	75	58.5	31.9
CD (5%)	**0.28**	**0.31**	**4.30**	**0.12**	**0.78**
CV%	**4.70**	**6.80**	**4.21**	**0.22**	**1.70**

3.3.3 Chlorophyll content

The Chlorophyll content was found to be maximum (SPAD value) (31.9) in the treatment T_9 (T5+ Foliage spray of 0.2% EDTA Chelated micronutrient mixture). The flower yield per ha was found to be minimum (SPAD value) (20.1) in the treatment T_2 (19:19:19 NPK/m^2 (1.2 g @ alternate days interval)). “To synthesized more plant metabolites and ultimately led to Chlorophyll content” [35].

4. CONCLUSION

From this study it is concluded that treatment **T9** performed best in terms of plant height, number of branches, plant spread, number of leaves, chlorophyll content, days to first flowering, days to 50% flowering, flower diameter, in which fertigation was done at **8 days interval** (4.6 g of 19:19:19 + 0.2% EDTA Chelated micronutrient mixture per 4 plants).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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