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# OPTIMIZATION OF FERTIGATION SCHEDULE FOR CUT CHRYSANTHEMUM (*Dendranthema grandiflora* Tzvelev)

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**ABSTRACT :** A greenhouse study was conducted in 2013 to optimize the fertigation schedule for cut chrysanthemum var. Amalfi. The experiment was laid out in a randomized block design (RBD) consisting of nine treatments with three replications which included fertilizer levels at 75, 100, 125 and 150 per cent of recommended dose of fertilizers along with foliar spray of 0.2 per cent EDTA chelated micronutrient mixture to each of the fertilizer levels. The results revealed that 75% recommended dose of fertilizers @ 12:3:12 g NPK/$m^2$ along with 0.2 % EDTA micronutrient mixture as foliar spray significantly enhanced the growth, physiology and yield parameters. Also increased recommended dose of fertilizers i.e., 100 % per cent improved the total leaf area per plant, soluble protein content, flower diameter, flower stalk length and girth. Though certain flowering parameters were recorded high in 100 % RDF, Yield contributing parameters like plant height, root length and fresh weight, total chlorophyll contents, earliness in flowering, yield/$m^2$ and vase life showed superiority in 75 % RDF along with foliar spray of 0.2 per cent EDTA chelated micronutrient mixture.

***Keywords:*** *Chrysanthemum, fertigation, improved growth, physiology, yield.*

Chrysanthemum (*Dendranthema grandiflora* Tzvelev) is one of the most important cut flower grown mainly for international and domestic markets. It ranks third among the cut flowers next to rose and tulips. Application of optimum quantity of fertilizers to the crop enhances the uptake of proper nutrients from growing media by the root hairs and also nutrient application at the required time prevented the crop suffering from hidden hunger. At present, the chrysanthemum growers are not able to obtain good quality, since the production cost of this flower is increased due to increase in fertilizer cost. Yield and quality is mainly dependant on the balanced application of macro and micronutrients. Fertilizer use efficiency is very less in the conventional practice of soil application. Most of the soils of hilly tracts of Tamil Nadu have low pH which hinders the absorption of micronutrients (Ahsan *et al*., 1). Foliar application of micronutrients may be 6 - 20 times more efficient than soil application in increasing crop production and other growth parameters (Younis *et al*., 16). Optimizing fertilizer dose is the alternative method for correction of nutrient deficit problems. So, to improve the growth, yield and quality of the crop, this study was taken up to optimize the fertigation schedule for chrysanthemum under the protected conditions.

## MATERIALS AND METHODS

The present study was carried out at M/s. Salem Green Plants Ltd., one of the leading commercial growers of cut chrysanthemum at Yercaud, Salem District. The experiment was laid out in a randomized block design (RBD) with three replications. The climate of the area is sub-tropical. A standard variety 'Amalfi' was selected for the study. The experiment was carried out under the greenhouse with nine treatments *viz.,* $T_1$: Control (without fertilizers), $T_2$: 75 % RDF @ 12 : 3 : 12 g NPK/$m^2$ , $T_3$: 100 % RDF @ 16 : 4 : 16 g NPK/$m^2$ , $T_4$: 125 % RDF @ 20 : 5 : 20 g NPK/$m^2$ , $T_5$: 150 % RDF @ 24 : 6 : 24 g NPK/$m^2$ $T_6$: $T_2$ + Foliar spray of 0.2 % EDTA chelated micronutrient mixture, $T_7$: $T_3$ + Foliar spray of 0.2 % EDTA chelated micronutrient mixture, $T_8$: $T_4$ + Foliar spray of 0.2 % EDTA chelated micronutrient mixture, $T_9$: $T_5$ + Foliar spray of 0.2 % EDTA chelated micronutrient mixture. 75 per cent of phosphorus was applied uniformly to the treatment plots i.e., $T_2$ to $T_9$ at the time of planting. Micronutrient mixture containing Zinc-2.5 %, Iron-2.0%, B-0.1%, Manganese-1.0%, Magnesium-4.0%, Copper-0.1% and Molybdenum- 0.01%) were given at fortnightly interval as foliar and 0.2 % humic acid was given along with fertilizers to each treatment except control. 100 per cent dose of fertilizers was adopted by the growers for commercial cultivation. The observation on growth parameters such as plant height (cm), root length (cm) and root fresh weight (g) were recorded at critical stages. The physiological parameters viz. chlorophyll contents (mg/g) and soluble protein (mg/g) and yield parameters such as days to first flower bud

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appearance, days to harvest, flower stalk length and girth (cm), weight of cut stem (g), opened flower circumference (cm), cut stem yield/$m^2$ and vase life (days) were recorded throughout the cropping period. The data were statistically analyzed as per the method suggested by Panse and Sukhatme (11). The critical differences were worked out for 5 per cent (0.05) probability and the mean differences were compared using LSD test.

## RESULTS AND DISCUSSION

The present experiment was taken up to have a scientific base pertaining to impacts of different levels of fertilizer levels adopted in chrysanthemum cultivation and to schedule the requirement of fertilizers to the crop.

### Growth parameters

The growth parameters *viz*., plant height, root length and root fresh weight at critical stages such as vegetative growth, bud appearance and flowering stage were variably influenced by the fertigation levels and foliar application of micronutrient mixture (Table 1). The fertigation dose of 75 % RDF @ 12:3:12 g NPK/$m^2$ along with 0.2 % EDTA micronutrient mixture as foliar spray ($T_6$) significantly influenced the plant height at all the three stages *viz*., vegetative (76.40 cm), bud appearance (98.69 cm) and peak flowering stage (126.26 cm) ; This might be due to frequent application of fertilizers at convenient intervals, which increases the available nutrient status in the root zone thus increasing the uptake of nutrients and further influencing the growth of the plant. Sufficient supply of nutrients at frequent intervals might have increased the production of IAA which consequently would have shown stimulatory action, in terms of cell elongation and thus resulting in increased plant height. The root length was highest in the treatment $T_6$ i.e., 75 % RDF @ 12:3:12 g NPK/$m^2$ along with 0.2 % EDTA micronutrient mixture as foliar spray by registering 60.57 cm at vegetative, 90.34 cm at bud appearance and 138.89 cm length at flowering stage respectively. In contrast, root length of control plants was very short and thin. Similar trend was observed at all the stages of plant growth. This was because fertigation system allows applying the nutrient exactly and uniformly to the wetted root volume, where the active roots are concentrated. This remarkably increases the efficiency in the application of fertilizer which allows reduction in the dosage of fertilizers. Similar trend was also reported by and Deng *et al.* (3) in lychee. The root fresh weight was increased significantly with increasing the concentration of Phosphorus ($T_7$). It was observed that plants fertigated with higher dose phosphorus had thicker roots. The improved effect of phosphorus was also observed by Xu *et al*. (15) in lettuce.

**Table 1 : Effect of fertigation levels on growth parameters of chrysanthemum at critical stages under greenhouse condition**

| Treatment | Plant height (cm) | | | Root length (cm) | | | Root fresh weight (g) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Vegetative stage | Bud appearance stage | Flowering stage | Vegetative stage | Bud appearance stage | Flowering stage | Vegetative stage | Bud appearance stage | Flowering stage |
| $T_1$ | $52.06^{f}$ | $58.38^{f}$ | $68.59^{f}$ | $30.40^{g}$ | $45.97^{f}$ | $63.54^{f}$ | $1.34^{f}$ | $1.79^{h}$ | $1.85^{g}$ |
| $T_2$ | $65.82^{cd}$ | $80.67^{d}$ | $124.32^{b}$ | $54.40^{c}$ | $85.67^{b}$ | $132.59^{b}$ | $2.87^{d}$ | $3.16^{e}$ | $3.47^{e}$ |
| $T_3$ | $70.60^{b}$ | $92.11^{bc}$ | $121.35^{bc}$ | $52.67^{cd}$ | $88.57^{ab}$ | $131.24^{b}$ | $4.14^{b}$ | $5.06^{a}$ | $5.69^{b}$ |
| $T_4$ | $65.00^{d}$ | $80.69^{d}$ | $118.66^{cd}$ | $51.54^{de}$ | $70.33^{de}$ | $120.95^{cd}$ | $2.22^{e}$ | $2.97^{f}$ | $3.35^{e}$ |
| $T_5$ | $59.10^{e}$ | $75.82^{e}$ | $105.41^{e}$ | $49.27^{ef}$ | $73.68^{cd}$ | $112.35^{e}$ | $1.49^{f}$ | $2.13^{g}$ | $2.87^{f}$ |
| $T_6$ | $76.40^{a}$ | $98.69^{a}$ | $126.26^{b}$ | $60.57^{a}$ | $90.34^{a}$ | $138.89^{a}$ | $4.02^{b}$ | $4.87^{b}$ | $5.54^{b}$ |
| $T_7$ | $75.00^{a}$ | $94.16^{b}$ | $132.54^{a}$ | $57.12^{b}$ | $85.64^{b}$ | $135.76^{ab}$ | $4.90^{a}$ | $5.08^{a}$ | $6.12^{a}$ |
| $T_8$ | $64.60^{d}$ | $78.14^{de}$ | $115.03^{d}$ | $52.62^{cd}$ | $75.36^{c}$ | $122.35^{c}$ | $4.10^{b}$ | $4.57^{c}$ | $5.29^{c}$ |
| $T_9$ | $68.24^{bc}$ | $88.55^{c}$ | $108.18^{e}$ | $47.06^{f}$ | $69.67^{e}$ | $115.31^{de}$ | $3.32^{c}$ | $3.73^{d}$ | $4.44^{d}$ |
| CD (P=0.05) | 3.167 | 3.992 | 5.443 | 2.431 | 3.676 | 5.745 | 0.155 | 0.178 | 0.207 |

*Means followed by a common letter are not significantly different at the 5% level by LSD.

### Physiological parameters

Leaf area represents the foliage of plants that give excellent results for fertigation and foliar spraying of micronutrients (Fig 1.). In the present study, 100 % RDF @ 16 : 4 : 16 g NPK/$m^2$ along with 0.2 % EDTA

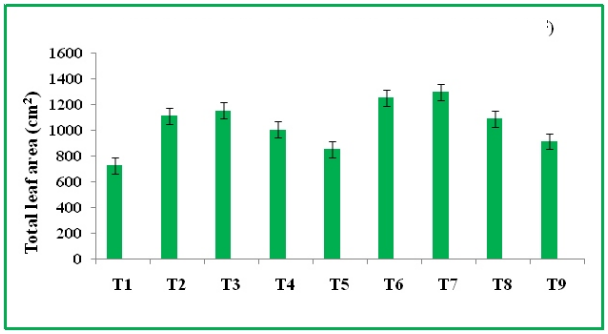


Fig. 1. Effect of fertigation levels on total leaf area per plant ($m^2$)

micronutrient mixture as foliar spray on 15 days interval ($T_7$) registered significantly the highest total leaf area per plant at the critical stages of the plant development *viz*., vegetative (968.49 $cm^2$), bud appearance (1256.59 $cm^2$) and flowering stage (1297.48 $cm^2$) and highest soluble protein content at the same critical stages (56.50, 67.19 and 71.66 mg $g^{-1}$ respectively). This increase in leaf area might be due to that the increased leaf numbers by the application of optimum dose of macronutrients at frequent intervals enhances the photosynthetic activity of the leaf ultimately increases leaf area. Increased vine length and girth as well as fruit size and quality due to fertifgation in cucumber was also reported by Tiwari (14). However, the treatment $T_6$, i.e., 75 % RDF @ 12:3:12 g NPK/$m^2$ along with 0.2 % EDTA micronutrient mixture as foliar spray proved similar effect which was at par with $T_7$ for all the parameters at all the critical stages of plants.

The chlorophyll contents are mainly influenced by the amount of light intensities received by the plants (Fig 2.). Fertigation levels of 75 % RDF @ 12:3:12 g NPK/$m^2$ along with 0.2 % EDTA micronutrient mixture as foliar spray influenced the total chlorophyll contents at the critical stages (1.96, 2.12 and 2.26 mg/g, respectively). The results are in agreement with Tiwari (14). In combination with micronutrients, it might have favoured the synthesis and accumulation of chlorophylls in plant system. Hebbar *et al*. (4) also revealed that being a constituent of chlorophyll, increased supply of nitrogen accelerate high synthesis of chlorophyll without altering the composition of chlorophyll *a* and *b*. The control ($T_1$) plants recorded the lowest chlorophyll contents at the critical stages.

Soluble protein content is a key factor in determining the photosynthetic efficiency of the crop plants. Soluble protein content was found to be recorded highest when 100 % RDF @ 16 : 4 : 16 g NPK/$m^2$ along with 0.2 % EDTA micronutrient mixture

**Table 2 : Effect of fertigation levels on yield and quality parameters of chrysanthemum under greenhouse condition.**

| Treatment | Days to first flower bud appearance | Days to first harvest | Flower stalk length (cm) | Flower stalk girth (cm) | Open flower circumference (cm) | Cut stem yield /$m^2$ | Vase life (days) |
|---|---|---|---|---|---|---|---|
| $T_1$ | $59.38^{g}$ | $105.98^{i}$ | $62.36^{h}$ | $2.37^{f}$ | $6.55^{h}$ | $65.24^{i}$ | $4.56^{f}$ |
| $T_2$ | $53.14^{cd}$ | $97.19^{d}$ | $116.34^{cd}$ | $2.82^{d}$ | $8.23^{cd}$ | $70.19^{f}$ | $9.54^{cd}$ |
| $T_3$ | $51.87^{bc}$ | $96.54^{c}$ | $118.69^{ab}$ | $3.07^{bc}$ | $8.59^{c}$ | $71.65^{e}$ | $9.64^{c}$ |
| $T_4$ | $56.74^{ef}$ | $100.01^{e}$ | $115.34^{d}$ | $2.79^{d}$ | $7.45^{fg}$ | $69.64^{g}$ | $8.49^{e}$ |
| $T_5$ | $57.52^{fg}$ | $101.36^{g}$ | $100.84^{g}$ | $2.97^{c}$ | $7.09^{g}$ | $68.59^{h}$ | $9.19^{d}$ |
| $T_6$ | $48.35^{a}$ | $90.23^{a}$ | $117.33^{bc}$ | $3.48^{a}$ | $9.64^{b}$ | $76.50^{a}$ | $11.56^{a}$ |
| $T_7$ | $50.26^{ab}$ | $94.36^{b}$ | $120.15^{a}$ | $3.34^{a}$ | $10.59^{a}$ | $74.32^{b}$ | $10.23^{b}$ |
| $T_8$ | $54.87^{de}$ | $100.98^{e}$ | $110.89^{e}$ | $2.59^{e}$ | $8.01^{de}$ | $72.68^{d}$ | $8.35^{e}$ |
| $T_9$ | $55.63^{def}$ | $102.87^{h}$ | $105.64^{f}$ | $3.12^{bc}$ | $7.66^{ef}$ | $73.49^{c}$ | $8.17^{e}$ |
| CD (P=0.05) | 2.590 | 0.360 | 1.9532 | 0.141 | 0.394 | 0.155 | 0.435 |

*Means followed by a common letter are not significantly different at the 5% level by LSD

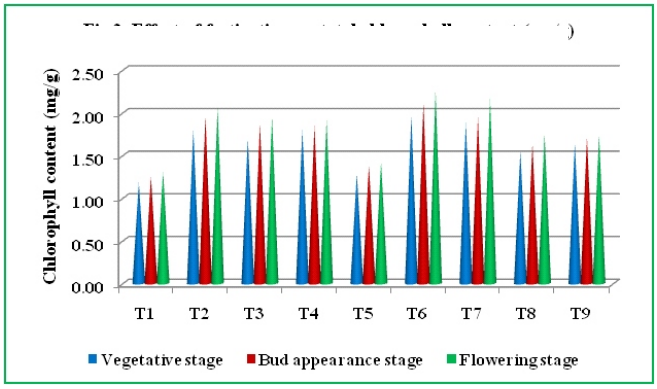


Fig. 2. Effect of fertigation on total chlorophyll content (mg/g).

as foliar spray on 15 days interval (Fig 3.). High N, P & K will intensify the protein synthesis by the way of supplying metabolic energy and also Zn present in the micronutrient mixture involved in the protein synthesis. Similar results were also obtained by Krishnamoorthy and Soorianathasundaram (8).

## Flowering and yield parameters

Days to flower bud appearance is an important parameter which decides the earliness of the crop yield (Table 2). In the present study, 75 % RDF @ 12:3:12 g NPK/$m^2$ along with 0.2 % EDTA micronutrient mixture as foliar spray significantly advanced the time taken for first flower bud appearance. Early flowering might be due to the combined effect of fertigation and foliar application of micronutrients which could have made a conducive source sink relationship. Also the continuous availability of proteins, amino acids, nucleic acid and various enzymes and coenzymes associated with the increased shoot length and leaf area resulted in more photosynthesis and thus increased the transformation of manufactured food material from source (leaf) to sink (flower bud). These findings are in line with those of Beniwal *et al*. (2) in gladiolus Joshi *et. al.* (5) in chrysanthemum, and Singh and Tiwari (12) in tomato.

Stalk length and girth are the most important parameters of chrysanthemum which directly related to hold the flower and improve the vase life. Application of different schedules of fertilizer levels revealed that 100 % RDF @ 16 : 4 : 16 g NPK/$m^2$ along with 0.2 % EDTA micronutrient mixture as foliar spray on 15 days interval ($T_7$) found to performed better for stalk length (120.15 cm) while 75 % RDF along with 0.2 % EDTA micronutrient mixture as foliar spray ($T_6$) registered the highest stalk girth (Table 2.). Combined application of fertigation and foliar application might have improved the length and girth of flower stalk and such influence could be described due to enhanced photosynthetic support optimized by presence of zinc and other micronutrients. This clearly indicated the necessity to provide combination of micronutrients to enhance the beneficial effects. Similar effects have also been documented in Kumar and Arora (10) and Singh *et al.* (13) in gladiolus. The beneficial effects of micronutrients have been clearly witnessed that 100 % RDF @ 16:4:16 g NPK/$m^2$ along with 0.2 % EDTA micronutrient mixture spray ($T_7$) influenced opened flower circumference (10.59 cm). The results are in concurrence with Khosa *et al*. (7) in gerbera and Katiyar *et al.* (6) in gladiolus. The circumference of flower was significantly improved by the application of water soluble fertilizers (WSF) through drip fertigation as they boost the overall vegetative growth.

Increased flower yield/$m^2$ was obtained when 75 % RDF @ 12:3:12 g NPK/$m^2$ along with 0.2 % EDTA micronutrient mixture spray ($T_6$) was used (Table 2). This might be attributed to the presence of soil organic acids inhibiting IAA oxidase enzyme and thereby increasing the flowering process. These findings are in agreement with those of Kumar (9) in chrysanthemum. The increase in flower yield by the application of iron and zinc elements producing healthy green leaves and in turn resulted in higher assimilate synthesis and partitioning of the flower growth. Per sq.m yield of 76.50 cut stems ($T_6$) in Amalfi was 17.26 per cent higher than control ($T_1$). Excellent flower quality with longer vase life fetches good market price. Longest vase life of flowers is the key issue in post harvest management of cut flowers and it assumed greater significance in flowers like chrysanthemum. The treatment of 75 % RDF @ 12:3:12 g NPK/$m^2$ along with 0.2 % EDTA micronutrient mixture spray at 15 days intervals resulted in the longest vase life. In chrysanthemum, the variation in vase life among the treatments might have attributed to the variation in levels of carbohydrate accumulation confirming to the reports of Joshi *et al.* (5). Continuous supply of micronutrients would have helped in maintenance of turgor in the leaf and flower and in turn favoured the higher vase life of carnation.

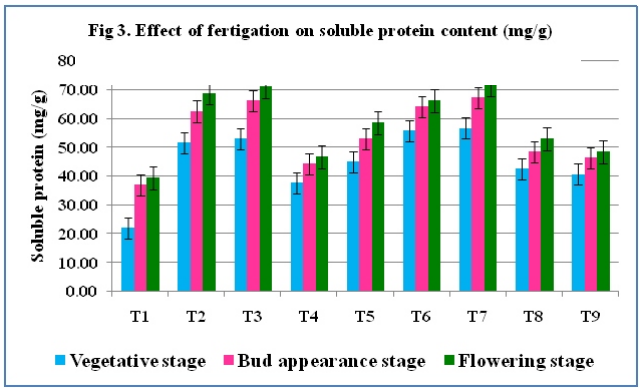


Fig. 3 : Effect of fertigation on soluble protein content (mg/g).

Based on the above results, it is recommended that 75 per cent of recommended dose of fertilizers at the rate of 12:3:12 g NPK/$m^2$ along with foliar spray of 0.2 per cent EDTA micronutrient mixture at 15 days intervals will improve the growth, physiology, yield and quality of cut chrysanthemum.

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