Proceedings of 15thAgricultural Research Symposium (2016) 322-325

Effect of Micronutrients on Growth and Flower Production of Chrysanthemum (*Chrysanthemum morifolium*)

W.M.T.K. WICKRAMASINGHE[1], G.D.G. CHATHURANI[2] and K. YAKNDAWALA[1]

[1]*Department of Horticulture and Landscape Gardening , Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura , Gonawila (NWP), 60170, Sri Lanka*

[2]*Regional Agriculture Research and Development Center, Bandarawela, 90100, Sri Lanka*

ABSTRACT

Chrysanthemum (*Chrysanthemum morifolium*) is an important commercial crop of the world and it belongs to the family Asteraceae. Plants need macro and micro nutrients for vegetative and reproductive growth. Soil provides macro and micro nutrients. When macro and micro nutrients are not enough for growth of plant, they should be applied as fertilizer. For chrysanthemum, there is no proper fertilizer recommendation especially for micro nutrients. Therefore, farmers use excessive amounts of fertilizer which cause additional cost. Fertilizer application can be used either as foliar application or soil application. Foliar fertilization provides more rapid utilization of nutrients. This experiment was carried out to investigate the effect of micro nutrients on vegetative and floral characteristics of *Chrysanthemum morifolium*. Chrysanthemum accession Bw-ch-035 was grown under protected environment. Five micro nutrient fertilizers, Fe(EDTA), Mn(EDTA), Cu(EDTA), Zn(EDTA), boric acid and complete micro nutrient mixture (micro™) was applied in two application methods *viz.*, foliar application and soil application. Significant interaction effect was not observed for the tested fertilizer types. Foliar application of Fe(EDTA) and Cu(EDTA) resulted late flowering. Flower diameter and number of flowers were significantly higher in soil application. According to this study, soil application is better than the foliar application. This could be due to the availability of nutrients over a longer period of time in the media. Further studies should be conducted to confirm this outcome.

KEYWORDS: *Chrysanthemum morifolium*, Foliar application, Micronutrient, Soil application

INTRODUCTION

Chrysathemum morifolium is a herbaceous perennial flowering plant of genus chrysanthemum, family Asteraceae. It is native to the northern hemisphere and widely distributed in Europe and Asia. However, it is believed that, its origin is in China (Saini *et al.*, 2015). Currently, Japan, China, Holland, France, England, America and India are the major commercial chrysanthemum producing countries (Patanwar *et al.*, 2014). However, chrysanthemum production in Sri Lanka is comparatively low. Up country wet zone and intermediate zone are suitable for the cultivation of chrysanthemum due to favorable climatic conditions for the production of high quality flowers which fetch higher price in the local market. To reach out the competitive export and domestic markets, quality plays a vital role in cut flowers (Ganesh and Kannan, 2013). Chrysanthemums are mainly grown for its cut flowers for making bouquets, garlands and for decoration for religious functions. (Patanwar *et al.*, 2014). Some species of chrysanthemum are also cultivated as souse of pyrethrum an important insecticide (Josi *et al.*, 2013). Chrysanthemum blooms are divided in to 13 different bloom forms such as regular, incurve, reflex, regular incurve, decorative, intermediate incurve, pompon, single and semi double, anemone, spoon, quill, spider, brush and unclassified or exotic by the USA National Chrysanthemum society (2016).

The nutrients supplied by macro and micro-elements are necessary for the various biochemical processes that occur within the plant, and are essential for normal plant growth and development (Darling, 1975). Yield and quality is mainly dependent on the balanced application of macro and micronutrients (Ganesh and Kannan, 2013).

Plants need 16 essential elements for growth. Macro nutrients should be applied in large quantities and micro nutrient in small quantities. Application of micronutrients either alone or in combination with macronutrients considerably enhance growth aspects of several ornamental plants (Mazroua *et al.*, 1988). Micronutrients are involved in all metabolic and cellular functions. Plants differ in their need for micronutrients: boron, iron, zinc, copper, chloride, manganese, molybdenum and nickel (Grusak, 2001). These elements are active that makes them essential as catalytically active cofactors of enzymes, others have enzyme-activating functions, and yet others fulfill a structural role in stabilizing proteins (Ganesh and Kannan, 2013). Improvement in growth characters due to micronutrient application might basically be due to enhanced photosynthetic and other metabolic activities

related to cell division and elongation (Hatwar *et al.*, 2003).

Foliar application of nutrients is an important crop management strategy in maximizing crop yields. It can supplement soil fertilization (Fageria *et al.*, 2009). When nutrients are applied to soils, they are absorbed by plant roots and translocated to aerial parts. In case of foliar application, the nutrients penetrate the cuticle of the leaf or the stomata and then enter the cells. Hence, crop response occurs in short time in foliar application compared to soil application (Fageria *et al.*, 2009). Further, foliar application has some positive effects. Practical problems associated with foliar fertilization include the detrimental effects of drought and increased leaf wax, the possibility of foliar burn, optimal timing of the foliar application during the day, and effects of various plant organs and organ age on absorption. Nutrient absorption can also be affected by environmental conditions, weather such as wind, temperature and humidity, the correct location of the spray in the canopy and leaf age (Oosterhuis, 2009).

Though chrysanthemum is popular, there is no proper fertilizer recommendation for this crop. Therefore, individual farmers use their own fertilizer management practices and the fertilizer mixtures available in the market in Sri Lanka.

There is no evidence of research work carried out on the effect of micronutrients on chrysanthemum in Sri Lanka. Therefore, this experiment aimed to find out the effect of different micro nutrients on plant growth and development and to find the best method of application.

MATERIALS AND METHODS

Location

The experiment was conducted during the period from December 2015 to May 2016 at the Regional Agriculture Research and Development Center, Bandarawela in up country intermediate zone, at an elevation of 1300 m above mean sea level. The average annual temperature is 24 °C.

Planting Materials

Apical shoots that were 5-6 cm long with 4-5 leaves were collected from selected mother plant of chrysanthemum accession BW-Ch-035.

Establishment and Maintenance

Apical cuttings were raised in nursery tray filled with red soil and maintained in shade under a poly tunnel. Three weeks old young nursery plants were transplanted in to black polythene bags (10×12 cm) filled with media consisting of Red soil : cattle manure : paddy charcoal : sand in 2: 2: 1: 1 ratio. As basal dressing urea, TSP (triple super phosphate), MOP (muriate of potash), $Ca(NO_3)_2$ and $MgSO_4$ were applied (Table 1).

Layout of Experiment

The experiment was laid out in two factor factorial CRD with 12 treatments. Each treatment consisted of ten replicates.

Treatments

Twelve different treatments consisted of the application of complete micro nutrient mixture: (Micro^{TM}) and five other micro nutrients Fe, Mn, Cu, Zn and B. These were tested using two different application methods (foliar and soil application). All six micro nutrient mixtures consisted of 0.25% concentration solutions and these were applied to plants in 2, 4, 6 and 8 weeks after planting (Table 2).

Table 1. Basal dressing used in the experiment

Fertilizer application	Urea (g)	TSP (g)	MOP (g)	$Ca(NO_3)_2$ (g)	$MgSO_4$ (g)
BD	1.5	2.5	1.0	2.0	1.5
TD1	1.5	-	-	-	-
TD2	1.5	-	2.0	-	-

BD- Basal dressing, TD1- Top dressing 1, TD2- Top dressing 2

Table 2. Tested micro nutrients and the method of application

Treatment	Fertilizer type	Method of application
T_1	complete micro nutrient mixture(micro^{TM})	Foliar
T_2	Fe(EDTA)	Foliar
T_3	Mn(EDTA)	Foliar
T_4	Cu(EDTA)	Foliar
T_5	Zn(EDTA)	Foliar
T_6	Boric acid	Foliar
T_7	complete micro nutrient Mixture(micro^{TM})	Soil
T_8	Fe(EDTA)	Soil
T_9	Mn(EDTA)	Soil
T_{10}	Cu(EDTA)	Soil
T_{11}	Zn(EDTA)	Soil
T_{12}	Boric acid	Soil

Growth Parameters

Plant height was recorded in each plot at weekly intervals until flowering started. At the flowering stage, number of leaves, axillary shoots, basal shoots and flowers, flower diameter, plant girth, bunch height, days to first flowering and vase life were recorded.

Statistical Analysis

Data from the experiments were statistically analyzed using SAS (Version 9.2) with GLM procedure.

RESULTS AND DISCUSSION

Mean vegetative and reproductive parameters obtained under two different application methods are given in Table 3, while mean vegetative and reproductive parameters obtained under different fertilizer types are given in Table 4.

Vegetative Morphological Characters

A significant difference was not observed between the two fertilizer application methods and among different fertilizer types for number of leaves, number of auxiliary shoots, number of basal shoots and plant girth (Table 3 and Table 4). Increasing axillary shoots is a positive character as it can increase the number of flowers. Therefore, it is important to increase chrysanthemum production.

There was no any significant difference in mean plant height measured in weekly intervals under soil application method (results not given). However, there was a significant difference in foliar application method (Table 5). Compared to other treatments throughout the experiment, plant height in T_4 (Cu application) was significantly low while that in T_2 (Fe application) significantly reduced from 6 weeks after planting (WAP). Symptoms of leaf burns were observed in both Cu and Fe foliar application methods.

Floral Characters

There was a significant difference in mean number of flowers and flower diameter in soil application method. However, a significant difference was not observed in number of days to first flowering, bunch height and vase life (Table 3). None of the floral characters were significantly different among different fertilizer types (Table 4).

Bunch height is one of the most important parameters of chrysanthemum, which is directly related to hold the flower and improve the vase life. When bunch height is increased, demand is also increased. However, in the present study, bunch height was not significantly increased in any of the treatments.

Days to 1st Flowering

Obtaining yield within a minimum period of time is important as it leads to increase the profit of the farmers. Compared to soil application, there was a significant increase in days to first flowering in foliar application under the treatments Fe(EDTA) and Cu (EDTA)(Table 6). However, early flowering was recorded in the treatment Micro™ which contain complete micro nutrient mixture in foliar application method. In foliar application of Cu and Fe, leaf burn was observed on plants. According to Fageria *et al.* (2009), leaf damage due to higher concentration of foliar fertilizer application may be one of the reasons for either yield decreases or the lack of yield increases; and, further foliar spray of nutrients should be avoided at high temperature during the day to avoid leaf burning.

Vase Life

A significant difference was not observed in between the two fertilizer application methods and among different fertilizer types applied on vase life of chrysanthemum.

Table 3. Mean vegetative and reproductive parameters obtained under two different application methods

Method of application	No. of leaves	No. of axillary shoots	No. of basal shoots	Plant girth (cm)	No. of flowers	Flower diameter (cm)	Days to 1st flowering	Bunch height (cm)	Vase life (days)
Foliar application	35[a]	25[a]	1[a]	2.90[a]	94[b]	3.21[b]	97[a]	50.53[a]	8[a]
Soil application	36[a]	27[a]	1[a]	2.92[a]	105[a]	3.37[a]	91[a]	48.81[a]	8[a]

Mean in column with the same letters are not significantly different at 0.05 level

Table 4. Mean vegetative and reproductive parameters obtained under six different fertilizer types

Fertilizer type	No. of leaves	No. of axillary shoots	No. of basal shoots	Plant girth (cm)	No. of flowers	Flower diameter (cm)	Flower bunch height (cm)	Vase life (days)
Micro™	34[a]	27[a]	1[a]	2.96[a]	108[a]	3.49[a]	49.11[a]	8[a]
Fe(EDTA)	36[a]	24[a]	1[a]	2.84[a]	98[a]	3.23[a]	51.05[a]	8[a]
Mn(EDTA)	36[a]	27[a]	1[a]	2.93[a]	105[a]	3.23[a]	47.12[a]	8[a]
Cu(EDTA)	36[a]	24[a]	1[a]	2.93[a]	93[a]	3.18[a]	52.39[a]	8[a]
Zn(EDTA)	35[a]	27[a]	1[a]	2.91[a]	95[a]	3.23[a]	49.97[a]	8[a]
Boric acid	35[a]	26[a]	1[a]	2.90[a]	98[a]	3.39[a]	48.37[a]	8[a]

Mean in column with the same letters are not significantly different at 0.05 level

Table 5. Mean plant height mesured in weekly intervels under foliar application method

Fertilizer type	4 WAP	5 WAP	6 WAP	7 WAP	8 WAP	9 WAP	10 WAP
Micro™	11.49^{a}	15.73^{a}	23.38^{a}	28.6^{a}	34.4^{a}	38.0^{a}	44.98^{a}
Fe(EDTA)	9.41^{ab}	12.44^{ab}	17.38^{bc}	21.14^{bc}	27.29^{bc}	31.71^{b}	38.74^{bc}
Mn(EDTA)	10.36^{a}	14.92^{ab}	21.88^{a}	26.66^{a}	33.3^{a}	38.94^{a}	43.56^{ab}
Cu(EDTA)	7.95^{b}	11.62^{b}	14.48^{c}	17.54^{c}	22.03^{c}	28.44^{b}	34.03^{c}
Zn(EDTA)	10.29^{a}	14.68^{ab}	21.96^{a}	26.33^{a}	32.84^{a}	39.33^{a}	44.13^{ab}
Boric acid	9.38^{ab}	12.93^{ab}	19.20^{ab}	24.22^{ab}	31.84^{ab}	38.46^{a}	44.98^{a}

Mean in column with the same letters are not significantly different at 0.05 level, WAP- Week after planting

Table 6. Days to 1st flowering obtained from two different application methods

Applied method	Fertilizer type					
	Micro™	Fe(EDTA)	Mn(EDTA)	Cu(EDTA)	Zn(EDTA)	Boric acid
foliar application	86^{a}	108^{a}	95^{a}	111^{a}	91^{a}	92^{a}
soil application	91^{a}	88^{b}	88^{a}	94^{b}	91^{a}	91^{a}

Mean in column with the same letters are not significantly different at 0.05 level

According to the present study, there was no any significant effect of individual micro nutrient fertilizers on the growth and reproductive parameters of Chrysanthemum. The lowest number of days to flowering, highest flower diameter and highest number of flowers were observed in the treatment Micro™ which contain all micro nutrients (Table 4). Further, soil application recorded better performances over foliar application. This could be due to the availability of nutrients over a longer period of time as this study was conducted inside a poly tunnel.

CONCLUSIONS

According to the present study, there was no effect of individual micro nutrients on *Chrysanthemum morifolium* and soil application recorded better performance compared to foliar application. Leaf burn was observed in plants sprayed with Fe(EDTA) and Cu(EDTA). Further, late flowering was observed in those treatments.

ACKNOWLEDGMENTS

The authors offer their sincere gratitude to Mr. K.P. Somachandra, Director and all the staff members in Regional Agriculture Research and Development Center, Bandarawela and Mr. K.H.M.I. Karunarathne, Information and Communication Technology unit, Wayamba university of Sri Lanka, for the help given in statistical analysis.

REFERENCES

Darling, R.M. (1975). Plant physiology. 3rd (ed.), Affiliated East West Press Put. Ltd., New Delhi.

Fageria, N.K., Barbosalfilho, M.P. and Moreira, A. (2009). Foliar fertilization of crop plants. *Journal of plant nutrition*,**32**, 1044–1064.

Ganesh, S. and Kannan, M. (2013). Essentiality of micronutrients in flower crops. *Journal of agriculture and allied sciences*, **2** (3), 52–57.

Grusak, M.A. (2001). Plant macro and micronutrient minerals. *Encyclopedia of life sciences*.Nature publishing group 1- 5.

Hatwar, G.P., Gondane, S.U., Urkude, S.M. and Gahukar, O.V. (2003). Effect of micronutrients on growth and yield of chilli. *Soils and crops*, **13**, 123-125.

Joshi, N.S., Dulawat, M.S., Pathak, D.M. and Patel, N.V. (2013). Effect of different dose of chemical fertilizers on quality and nutrient content of Chrysanthemum varieties. *Journal of chemical, biological and physical sciences*, **3** (1), 31–40.

Mazroua, M.M., Afify, M.M. and Eraki, M.A. (1988). Effect of foliar fertilizer on the growth and flowering characters of *Chrysanthemum morifolium* Ram. Plants. *Journal of agriculture research*, **13**, 397-413.

National Chrysanthemum society (2016). Chrysanthemum classifications. National chrysanthemum society USA. Available from :http://www.mums.org/chrysanthemum-classes (Accessed on 19 May 2016).

Oosterhuis, D. (2009). Foliar fertilization: mechanisms and magnitude of nutrient uptake. *Paper for the fluid fertilizer foundation meeting in Scottsdale, Arizona*, **4**, 15-17.

Patanwar, M., Sharma, G., Banjare, C., Chandravanshi, D. and Sahu, E. (2014). Growth and development of chrysanthemum (*Dendranthema grandiflora* Tzvelev) as influenced by integrated management. *Journal of environmental sciences*, **3**, 459-462.

Saini, C.E., Polara, N.D. and Bajad, A.A. (2015). Effect of micronutrients (Fe and Zn) on growth of chrysanthemum (*Chrysanthemum morifolium* Ramat). *The asian journal of horticulture*, **10** (2), 216–221.