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Production of Quality Dahlia *(Dahlia variabilis* cv. Redskin*)* Flowers by Efficient Nutrients Management
Running Title: Plant Nutrition Impacts on Dahlia Quality

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Abstract: Dahlia is a beautiful flowering plant grown for cut flower production and for garden decoration but its growth is restricted due to limited supply of micro and macro nutrients in the soil. To get quality flowers, nutrient optimization is required and there is a need of estimation of its growth pattern, consumption of nutrients and relative effectiveness of different nutrient levels on its health and vigor. The present study was performed to optimize doses of micro and macro nutrients on growth and flowering of dahlia. The results indicated that micronutrient concentration of 7.5 mlL^{-1} and macronutrient concentration of 6 ml L^{-1} proved best with the maximum values for plant height, number of leaves, number of side shoots, leaf area, number of tubers per plant, flower diameter and least days to flower emergence of dahlia. The other treatments although exhibited better response than control treatment but their effect on growth were lesser than T_{15}.

Key words: Bedding plant · Dahlia · Cut flower · Micro and macro nutrients

INTRODUCTION

Dahlia a greatly appreciated flowering bulbs belongs to family *Compositeae* and having 35 species with more than one thousand distinct cultivars all over the world [1, 2]. It is a perennial, half hardy, herbaceous plant with tuberous root system and erect growing habit. The long lasting quality of flower is of great importance in the cut flower trade. In our country due to the great diversity in climatic conditions the flowers can be raised for trading during a long spell of the year [3].

The growth and quality of flower and tubers are influenced by numerous environmental aspects like soil type and the nutrients availability and these are the most essential factors for appropriate growth [4]. Dahlia requires well balanced fertilizer like all floricultural crops need for its optimum plant growth and flower development [5]. The optimal dose of nutrition can ensure increase flower yield with healthy plant growth [6] as nutrition is an important factor which is directly related to growth and flowering of dahlia [3]. Mukesh *et al*. [7] depicted that compound fertilizer application of N@ 50 g/m², P @ 10 g/m² and K at 20 g/m² in gladiolus produced more number of florets per spike, maximum spike weight, bigger flower size, with uniform opening of florets as well as more size and weight of corms and number of corms. Ewees *et al.* [8] studied that all vegetative and reproductive characteristics of dahlia plant were increased with the application of B, Zn, Fe and Mn at different concentrations. Therefore, it is essential to provide optimize amount of N, P and K to obtain the best vegetative and reproductive growth. Different experiments regarding fertilizer applications have been conducted in different parts of the world to improve the growth and flowering of ornamentals [3].

Most of the soils in Pakistan have high pH value (alkaline), which hinders the absorption of nutrients [9]. Foliar application is one of the methods to overcome this failure of plants to absorb certain nutrients necessary for normal growth [10]. In flower crops integrated micronutrients and macronutrients application in suitable quantity and appropriate proportions are the essential factors that control the plant growth and micronutrients requirements differ for plants [11]. Foliar application is

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gaining more importance in fertilization of various field and floricultural crops [12]. The advantages of foliar fertilization are more obvious under growing conditions restricting the absorption of nutrients from the soil [13]. In circumstances, when the other soil properties may cause hindrance in the uptake of nutrients, foliar application is preferred method [14]. Foliar application is one of the best ways to supply micronutrients to plants [15]. Therefore, this study was conducted to produce best quality flowers by application of macro and micronutrients through foliar method of application of these nutrients and to quantify the optimum concentrations of nutrients applications of in order to get best growth and quality attributes of dahlia plants.

MATERIALS AND METHODS

The present experiment was executed in Floriculture Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan, during 2010-11. Dahlia "*Dahlia variabilis* cv. redskin" seeds were purchased from a local plant nursery, Faisalabad. Nursery of the Dahlia cv. redskin was raised through sowing seeds in clay pots during the month of November. When seedlings attained 4-5 inch height they were then shifted in 12 inches pots during the month of December. Source of macro and micro nutrients like Foliber a macro nutrient product containing ingredients with concentration g/L: nitrogen (N) 80, P_2O_5 80 and K_2O 60 and Unipower solution a micro nutrient product containing ingredients with concentration in mg/100 ml: Zinc (Zn) 5000±200, Boron (B) 4000±200, Iron (Fe) 5000±200, Manganese (Mn) 1000±200, Copper (Cu) 1000±100, Chloride (Cl) 1000±100, Molybdenum (Mo) 50±10 and pH of the solution 2.5±0.5 were used. This unipower solution was taken from Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad. Different combinations of different concentrations of Foliber and Unipower were made and applied to dahlia plants at different intervals viz. with a seven days rotation. There were 16 treatment combinations comprising T_0=Control, T_1= 2.5 Unipower (ml/L), T_2= 5.00 Unipower (ml/L), T_3= 7.5 Unipower (ml/L), T_4= 2.00 Foliber (ml/L), T_5= 2.00 Foliber (ml/L)+ 2 .5 Unipower (ml/L), T6= 2.00 Foliber (ml/L) +5.00 Unipower (ml/L), T7= 2.00 Foliber (ml/L) +7.5 Unipower (ml/L), T8= 4.00 Foliber (ml/L), T9= 4.00 Foliber (ml/L)+2.5 Unipower (ml/L), T10= 4.00 Foliber (ml/L)+5.00 Unipower (ml/L), T11= 4.00 Foliber (ml/L) +7.5 Unipower (ml/L), T12= 6.00 Foliber (ml/L), T13= 6.00 Foliber (ml/L) +2.5 Unipower (ml/L), T14= 6.00 Foliber (ml/L) +5.00 Unipower (ml/L) and T15= 6.00 Foliber (ml/L) +7.5 Unipower (ml/L). Plants were allowed to grow and data regarding following growth and flowering was collected using standard procedures. The parameters studied were: Plant height (cm), number of lateral shoots, length of lateral shoots, number of leaves /plant, leaf area (cm²), days to first flower emergence, root length, blooming period (Days), size of flowers (cm), number of flowers/ plant and number of tubers/ plant. The experiment was laid out according to completely randomized design (CRD) with four replications and sixteen treatments making a total population of 192 plants the experiment. Collected data for morphological traits and chemical analysis of media was analyzed by using analysis of variances (ANOVA) to check any differences between the means. Significant means were compared by using Duncan's Multiple Range (DMR) test at 5% probability level [16].

RESULTS

The quality production of dahlia plants can be achieved by the use of suitable micro and macro nutrients, which have a prominent effect on growth and flowering. In order to attain this objective, different concentrations of Foliber and Unipower were made and applied dahlia at different intervals. The collected data regarding the vegetative and reproductive characteristics were analyzed statistically at a 5% probability level and ANOVA showed highly significant results. It was observed that tallest plants 49.08 cm were obtained in T_{15} (6 ml/L Foliber, 7.5 ml/L Unipower) followed by 48.2 cm in T_{14} (6.00 ml/L Foliber +5.00 ml/L Unipower). Lowest plant height was observed in T_0 (Control) where no micro and macro nutrients were applied (Table 1). The maximum number brunches per plant (26.00) and the longest branches (24.75 cm) were obtained with T_{15} (6 ml/L Foliber,7.5 ml/L Unipower), while the lowest number of brunches per plant (10.00) and length branches (12.06 cm) were observed in T_0 (Control) where no micro and macro nutrients were applied. The highest count of leaves per plant (108.33) was gained with T_{15} (6 ml/L Foliber, 7.5 ml/L Unipower) but it was not statistically different from T_{14} (6.00 ml/L Foliber +5.00 ml/L Unipower), T_{13} (6.00 ml/L Foliber +2.5 ml/L Unipower), T_{11} (4.00 ml/L Foliber +7.5 ml/L Unipower) and T_{10} (4.00 ml/L Foliber +5.00 ml/L Unipower). The maximum leaf area 18.20, 17.20 and 17.20 cm^2 without statistical difference was observed in T_{15}, T_{11}

Table 1: Response of Different levels of Foliber and Unipower on growth of Dahlia

Treatments	Plant height (cm)	No of branches	Length of branches (cm)	No of leaves/ plant	Leaf area (cm^2)	No of days to emerge first flower	Root length (cm)
T_0	32.81 g	10.00 i	12.06 f	54.17 f	9.14 c	100.10 e	12.83d
T_1	33.96 fg	12.16 hi	14.68 ef	63.50 ef	10.70 bc	99.33 de	13.13 cd
T_2	34.92 efg	13.00 ghi	15.04 ef	64.00 def	12.22 abc	98.33 de	13.76 cd
T_3	36.25 defg	14.00 fgh	13.33 f	70.00 cde	12.96 abc	98.50 de	14.18 cd
T_4	34.85 efg	14.33 fgh	12.57 f	69.00 cde	13.01 abc	99.83 e	13.13 cd
T_5	36.27 defg	16.50 defg	15.25 def	75.83 c	14.98 abc	97.17 cde	14.85 cd
T_6	38.12 def	18.00 de	15.51 cdef	76.67 c	15.09 abc	91.83 abcde	15.18 cd
T_7	39.5 cd	21.83 bc	19.10 bcd	87.33 b	15.74 ab	91.17 abcde	16.93 bc
T_8	36.37 defg	15.50 efgh	15.91 cdef	65.00 de	13.03 abc	97.17 cde	13.68 cd
T_9	38.88 cde	19.83 cd	18.53 bcde	71.83 cde	13.53 abc	93.33 bcde	15.71 cd
T_{10}	39.77 cd	23.18 abc	19.27 bc	100.83 a	14.12 abc	85.33 abcd	16.88 bc
T_{11}	43.98 b	23.33 abc	21.37 ab	103.83 a	17.20 a	78.50 a	19.98 ab
T_{12}	37.83 def	17.50 def	13.80 f	73.67 cd	13.10 abc	96.00 bcde	16.06 cd
T_{13}	42.2 bc	23.50 ab	20.27 b	100.17 a	15.00 abc	84.33 abc	20.8 a
T_{14}	48.2 a	24.33 ab	21.66 ab	102.83 a	17.20 a	82.33 ab	21.26 a
T_{15}	49.08 a	26.00 a	24.75 a	108.33 a	18.20 a	79.50 a	22.08 a

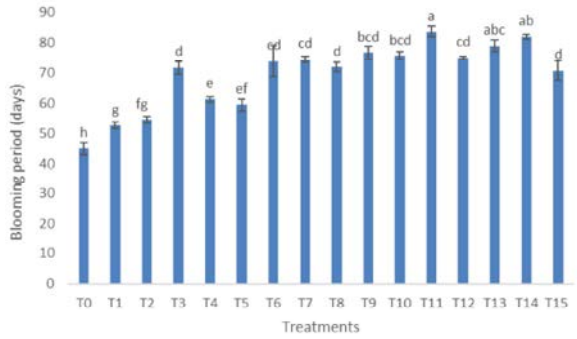

Fig. 1: Response of different levels of Foliber and Unipower on blooming period in Dahlia

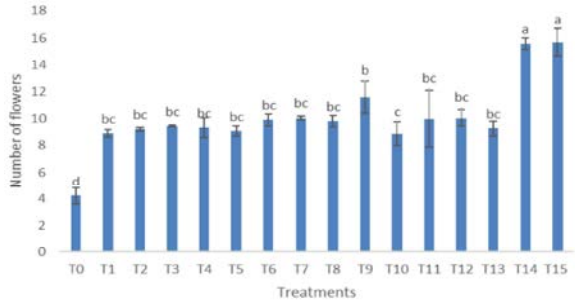

Fig. 2: Response of different levels of Foliber and Unipower on number of flowers in Dahlia

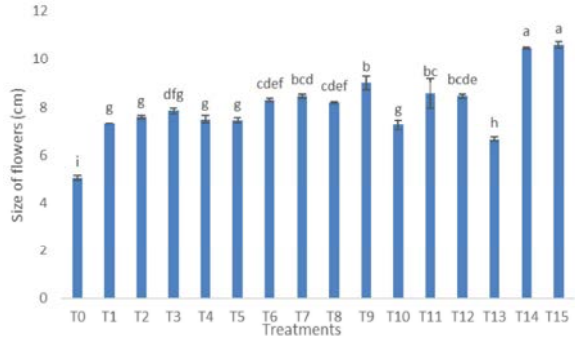

Fig. 3: Response of different levels of Foliber and Unipower on flower size in Dahlia

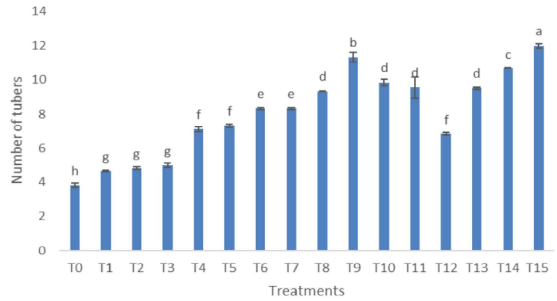

Fig .4: Response of different levels of Foliber and Unipower on number of tubers in Dahlia

and T_{14} respectively. Earliest flowering was observed in T_{15} and T_{11} (79.50 and 78.50 respectively) as plants under these treatments took least days to emerge first flower. The other fertilizers combination however revealed better results compared with control as they were significantly different from T_0.

Results regarding blooming period showed that longest flowering duration (83.66 days) was observed in T_{11} (4.00 ml/L Foliber +7.5 ml/L Unipower) followed by 82 days and 79 days in T_{14} and T_{13}, respectively. Although T_0 (control) produced flower for shortest duration (45 days) as compared to other treatments (Fig. 1).

Flower count per plant was highest in T_{15} and T_{14} with 15.70 and 15.58 flowers per plant respectively (Fig. 2). All the treatments contributed significantly to increase number of flowers per plants as compared to control which produced least number of flowers (4.20). Similarly, flower size was maximum in T_{15} and T_{14} with 10.60 and 10.48 cm, respectively (Fig. 3), these results revealed significant contribution to increase flower size in all the treatments as compared to control which produced smallest flower size (5.07 cm). Plants produced maximum number of tubers per plant (12.00) in T_{15} (6 ml/L Foliber, 7.5 ml/L Unipower) while their number was lowest (3.83) in control (Fig.4).

DISCUSSION

This study leads to reveal the fertilizer requirement for best vegetative and reproductive growth. Vegetative characteristics of plants are greatly subjective to genetic and environmental factors coupled with optimum fertilizer application method [17]. In this study, variety and environmental conditions were similar but the amount of fertilizer application was different. The difference in plant morphological characteristics may be due to the use of variable amount of macro and micro nutrients in different combinations. After comparing treatment means it was found that T_{15} (6 ml/L Foliber, 7.5 ml/L Unipower) proved best treatment under present experimental conditions. The other fertilizers combinations even though gave better effects than control treatment but their effect was lesser than T_{15}. In treatments: T_{14} and T_{13} the macro and micro elements combination was slightly different compared with T_{15} which indicated that the NPK supplemented with micro nutrients was optimum in T_{15} .

A further analysis of data indicated that high amount of macro nutrients along with micro nutrients gave better performance and vice versa. Mentioned results regarding plant height are well-supported by Younis *et al.* [5] as the mixture of macro and micronutrients was found to produce maximum plant height relative to other combinations. Plants applied with different levels of micro and macro nutrients varies in plant height, the plants which received least amount of these nutrient remains short. The results are confirmed by other studies that high level of macro nutrients (NPK) produced maximum number of leaves [18, 19]. Results regarding plant height, length of branches per plant, number of branches per plant, leaf area, number of leave per plant, days to first flower emergence and flower diameter were supported by Khosa *et al.* [12], as they reported increase in growth and flowering with the increasing fertilization level of macro and micro nutrients. Number of flowers per plant was increased with the combination of macro-nutrients and micro-nutrients as foliar application [20]. Similarly, confirmatory results were reported by Baloch *et al*. [21] who performed an experiment to evaluate the effect of NPK elements on the growth and flower production of *Zinnia elegans* L. whereas, Younis *et al*. [22] also evaluated the effect of N, P and K on growth of Dahlia. Present results were also in line with the results of Bankar [23], Chaturvedi *et al*. [24] and Mostafa *et al*. [25].

Mahgoub *et al.* [26] study the same response of Schefflera plants to foliar fertilizer and ammonium nitrate and their interaction. The application of the two factors used in this study significantly affect the vegetative growth expressed as plant height, number of leaves, leaf area, stem diameter, fresh and dry plant weight. The present results are in accordance with the results of Parthiban *et al*. [27], Ahmad *et al.* [3], Singh and Gupta [28], Iersel *et al*. [29]. Balance nutrition application in plants results in vigorous vegetative and reproductive growth. Present investigation showed that presence of macro nutrients enhance plant growth and flowering as N increases the vegetative growth of crop plants and it is most important for preparation of starch in leaves and production of amino acids [30]. Phosphorus, like Nitrogen, is also important, as it is the structural part of many compounds, notably nucleic acid and phospholipids. In addition to this, phosphorus plays an important role in energy metabolism [31]. Amount of P and K ensure flowering in plants and results in healthier reproductive growth whereas N is inevitable for vegetative growth in plants. Similarly, micronutrients also play a vital role in growth and development of plant because of its stimulatory and catalytic effect in various physiological and metabolic processes of plants [32]. Micronutrients are vital for organization and rapid alternation of nutrition compound within plant due to their important role in activation of enzymes for metabolism [33]. As in the past, micronutrients were naturally provided by soil so there was no demand of these trace elements. With the passage of time, the rigorous farming, increase in soil salinity and soil pH, in most of soils, these nutrients are present but are not available to plants [11]. The present study revealed that the foliar application of N, P, K, boron, Zn and Fe increased the yield and quality of flower in dahlia. Therefore, the application of micronutrients at optimum concentrations are very important as their concentrations have great influence on growth and quality attributes of dahlia. It is clear from present results that plants supplied

with optimum combinations of NPK macro elements (Foliber) with micro nutrients (Unipower) there is a balance in vegetative and reproductive growth of plant.

CONCLUSION

High-quality production of dahlia can be attained by using most suitable macro and micronutrients. In this study, the results associated with plant growth parameters indicated that the maximum values for plant height, number of leaves, number of side shoots, leaf area, number of tubers plant, flower diameter and least days to flower emergence were observed in combined application of macro and micronutrients containing 6 ml/L Foliber and 7.5 ml/L Unipower. This combination has sufficient amounts of the nutrients essential for plant growth so this best combination of macro and micronutrients having 6 ml/L Foliber and 7.5 ml/L Unipower for good vegetative and flower growth in dahlia is recommended.

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