Impact of pyridoxine (B6) and fulvic acid on the floral growth characteristics of Chrysanthemum plant, Dendranthema grandiflorum Ramat

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Abstract

During the autumn season of 2023-2024, a pot experiment was carried out in one of the plastic houses of Baqubah Nursery affiliated to the Directorate of Agriculture in Diyala Governorate to study the effect of fulvic acid at concentrations of 0, 0.5, 1.0, and 1.5 g/L and foliar spraying with pyridoxine vitamin at concentrations of 0, 50, 100, and 150 mg/L on the floral growth of Chrysanthemum plants, Dendranthema grandiflorum Ramat, Morgana cultivar. Two weeks after transferring the seedlings to the pots, the plants were sprayed twice with the specified concentrations of fulvic acid and vitamin pyridoxine, with a 15-day interval between each spray and the other. The research was carried out as a factorial experiment according to the randomized complete block design (RCBD) and with three replicates. The study revealed that all fulvic acid spray treatments improved most of the floral growth characteristics of the Chrysanthemum plant, and the concentration of 1.5 g/L was superior in recording the highest results of flower diameter 9.7 cm, flower stem diameter 4.31 mm, flower survival time on the plant 32.98 days, fresh flower weight 13.17 g, and flower dry weight 6.58 g, also the pyridoxine vitamin improving the floral growth characteristics of the Chrysanthemum plant, and the concentration of 150 mg/L recorded the best results of flower diameter 9.6 cm, flower stem diameter 3.96 mm, flower survival time on plant 29.38 days, fresh flower weight 11.33 g, and dry flower weight 5.66 g. The interaction treatment between spraying with pyridoxine at a concentration of 150 mg/L and fulvic acid at a concentration of 1.5 g/L showed a significant difference in floral characteristics such as flower stem diameter 4.43 mm, flower survival time on the plant 35.17 days, fresh flower weight 14.28 g, dry flower weight 7.14 g, and flower diameter 10.6 cm .

Keywords. Chrysanthemum plant, fulvic acid, pyridoxine

Introduction

Ornamental plant cultivation is one of the most advanced agricultural activities in many countries of the world [18]. Among the main ornamental plant products is the Chrysanthemum plant Dendranthema grandiflorum Ramat. The importance of Chrysanthemum is highlighted as a potted plant and as basins and garden plants. The commercial value of the Chrysanthemum plant is directly related to the size and quality of leaves, stems, and flowers [17]. Some of its species are annual and others are perennial, and most of them are herbaceous, but a few of them are semi-woody [7]. Chrysanthemum flowers, known as the Queen of Autumn flowers [12], are one of the most important flowers to harvest in the autumn because they bloom for most of the year when there aren't many other flowers in the garden. Chrysanthemum is one of the most important ornamental crops in the world, and it comes second in commercially picked flowers after

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roses. The success of growing this plant is due to the enormous diversity of varieties with countless colors, different flower shapes and sizes, and methods of rotating varieties, which always offer something new to the consumer, as there are more than 150-200 known types of Chrysanthemum belonging to the Asteraceae family [23]. To reduce the problem of oxidation and increase soil fertility, many researchers have started using humic acids such as fulvic and humic acids to improve soil properties and plant growth. The production of ornamental plants in alkaline soils is often limited due to the lack of nutrients [15]. In general, the use of organic matter (fulvic and humic acids) is necessary to achieve beneficial benefits in this type of soil. These organic matter consists of various nitrogenous compounds including decomposed amino and aromatic compounds [4]. Fulvic acid has a direct and indirect role in plant growth by improving soil particle aggregation, aeration, microbial growth, organic matter mineralization, water holding capacity, and transport of macro and micronutrients through humic substances indirectly [25,24,9]. Cell walls, photosynthesis, and respiration rate in plants are directly affected by humic substances [20], which are known to enhance root growth and nutrient uptake [14]. Vitamins can be considered as biological growth-regulating compounds that, at relatively low concentrations, exert profound effects on plant growth-regulating factors that affect many physiological processes, such as enzyme synthesis, and act as coenzymes and influence plant growth [21,19]. Vitamins can now be used as natural and safe (environmentally friendly) substances to improve plant growth and flowering. In this regard, it is recommended to use vitamin Pyridoxine B6, which contributes to the activation of vital activities within living cells and thus increases the growth rate and improves plant performance. Vitamins are known to be nutritional factors required for the growth of all living organisms, although we know that vitamins are synthesized internally [10], their external addition has mostly had positive effects on plant growth, carbon dioxide absorption and protein synthesis [5]. Pyridoxine, in its active form Pyridoxal5-phosphate, is an essential metabolic compound in all living organisms. It can act as a coenzyme for many metabolic enzymes [11]. It has recently been shown to be a powerful antioxidant and is a requirement for growth and differentiation of some plant species [22]. Therefore, the aim of this study is to evaluate the impact of pyridoxine vitamin and fulvic acid on the floral and vegetative growth of Chrysanthemum plants.

Materials and methods

The experiment was carried out during the autumn season from 20/10/2023 to 20/6/2024 in one of the plastic houses of the Baqubah Nursery in the Diyala Agriculture Directorate. The homogeneous seedlings were selected in height approximately 15 cm and transferred to plastic pots with a diameter of 25 cm, with one plant in each pot. The pots contain a growing medium consisting of 3 soil: 1 peat moss. Random samples were taken from it for analysis and sent to the Soil and Water Division in the Agriculture Directorate in Diyala Governorate (Table 1). The growing medium was sterilized with the systemic fungicide, Hymex, a liquid pesticide, and the active ingredient in it is Hemexazole 300 g/L after filling it in the pots. After completing the seedling transformation process, the plants were fertilized with Triplex balanced NPK fertilizer (20, 20, 20). The fertilizer was added by spraying at a rate of 2 g/L, at a rate of one

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spray every two weeks, and the Bloom fertilizer was used at a rate of 20 g/L of water.
The factorial experiment includes two factors according to the RCBD design with three replicates. The first factor represents spraying fulvic acid at concentrations of 0, 0.5, 1.0, and 1.5 g/L and the second factor represents spraying pyridoxine at concentrations of 0, 50, 100, and 150 mg/L. The plants are sprayed with the specified concentrations of fulvic acid and pyridoxine twice, two weeks after transferring the seedlings to the pots, and with an interval of 15 days between one spray and the next. The number of treatments and their combinations used in the experiment was 16 treatments, and the number of experimental units was 48, with 8 plants in each experimental unit. Thus, the number of plants in the experiment was 384 plants. The data were analyzed according to the statistical program SAS (2003), and the means were compared using Duncan's multiple range test at a probability level of 0.05 [2 .[

Table 1. The physical and chemical properties of soil

Measurements	Value	Unit of measurement
Texture of soil	Sand	-
Clay	4.58	g. kg^{-1}
Silt	12.48	g. kg^{-1}
Sand	82.96	g. kg^{-1}
Ph	7.2	-
Ec	1.48	$ds.m^{-1}$
N	40	mg. kg^{-1}
P	24.3	mg. kg^{-1}
K	89	mg. kg^{-1}
Organic matter	0.4	%
CaCo3	5	g. kg^{-1}

The study characteristics
Flower diameter (cm(

Fully opened flowers were selected to measure their diameter using vernier, and the distance between the two furthest points of the petals was measured and its average was calculated.
Diameter of flower stem (mm(
The diameter of the flower stems was measured from the thickest area on the flower stem using digital vernier, and the average of each experimental unit was calculated.
Flower survival time on the plant (day(
The number of days from the opening of the flower bud until the beginning of its wilting was calculated.
Fresh weight of the flower (g(
The fresh weight was measured using a sensitive balance by picking eight flowers from each experimental unit, measuring the fresh weight of each flower, and then calculating the average fresh weight of the flower in one plant.
Dry weight of the flower (g(

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The dry weight of the eight flowers was calculated after air drying them at room temperature in a shaded place until the weight was fixed.

Results and discussion

The results of Tables (2,3,4,5, and 6) indicate that there are significant differences between the levels of pyridoxine in the flower diameter, diameter of flower stem, flower survival time on the plant, fresh weight of the flower, and dry weight of the flower, as the treatment of 150 mg/L outperformed with the highest value and significantly in these characteristics, reaching 9.6 cm, 3.96 mm, 29.38 day, 11.33 g, and 5.66 g compared to the control treatment, which gave the lowest value, reaching 7.5 cm, 3.72 mm, 26.44 day, 10.13 g, and 5.06 g, respectively. As for the effect of fulvic acid treatment in the previous traits, the results show that there are significant differences in their levels, as the treatment of 1.5 g/L outperformed significantly in giving the highest rate, reaching 9.7 cm, 4.31 mm, 32.98 day, 13.17 g, and 6.53 g, while the control treatment gave the lowest rate, reaching 7.3 cm, 3.40 mm, 22.69 day, 8.71 g, and 4.35 g, respectively. The interaction between the spray treatments (pyridoxine and fulvic acid) had a significant effect on the value of the previous traits, as the treatment of pyridoxine 150 mg/L and fulvic acid 1.5 g/L was significantly superior with the highest value, reaching 10.6 cm, 4.43 mm, 35.17 day, 14.28 g, and 7.14 g compared to the control treatment, which recorded the lowest value, reaching 5.7 cm, 3.15 mm, 21.58 day, 7.85 g, and 3.92 g, respectively .

The results of the above tables indicate a significant superiority in most floral traits when using the study factors, particularly when the concentrations of both factors are increased. This may be due to the fact that fulvic contains organic carbohydrates that aid in photosynthesis processes and contribute significantly to cell division and growth processes. It is also characterized by its high oxygen content, which contributes to holding water and facilitating the transfer of nutrients within the plant and contributes as an enzyme catalyst for some important enzymes that enter into the plant's structure and tolerance of environmental stresses. Fulvic is considered one of the materials that easily enters into plant membranes because it has a small molecular weight and thus directly enters into the plant's growth and construction processes [20,6]. Pyridoxine plays a role in many important processes that help the plant grow and complete its life cycle, such as activating enzymes through the formation of enzyme cofactors, thus playing an important role in regulating biological energy pathways within the plant, especially in reduction processes [8], and works as a cofactor in many chemical reactions that occur in the cell, which contributes to the process of building carbohydrates [16]. Based on the importance of these factors in the vital processes within the plant, which in turn stimulated and contributed to increasing the efficiency of photosynthesis, this was observed through the results of the experiment, as these factors led to an increase in the total chlorophyll content in the leaves, carbohydrates, carotenoids, and the percentage of nitrogen, phosphorus, and potassium, thus positively affecting the rest of the studied traits, such as the diameter of the flower stem, the age of the flower on the plant, the dry weight of the flower, the content of carotenoids in the petals, the diameter of the flower, and the number of the petals of the flower, which is agree with [13,3,1.[

Conclusion

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It was found that increasing the pyridoxine and fulvic acid spraying concentration clearly improved all the floral traits under study for Chrysanthemum plants, with concentrations of 150 mg/L and 1.5 g/L, respectively, being the most effective .

Table 2. Effect of spraying with different concentrations of pyridoxine and fulvic acid and their interaction on flower diameter (cm(

Pyridoxine mg/L	Fulvic acid g/L				Mean
	0	0.5	1.0	1.5	
0	5.7 f	7.0 de	8.5 cd	8.9 abc	7.5 C
50	6.3 f	7.7 de	8.4 cd	9.3 abc	7.9 C
100	8.4 cd	8.4 cd	9.0 abc	10.1 ab	9.0 B
150	8.9 abc	9.6 abc	9.5 abc	10.6 a	9.6 A
Mean	7.3 D	8.2 C	8.9 B	9.7 A	

Table 3. Effect of spraying with different concentrations of pyridoxine and fulvic acid and their interaction on diameter of flower stem (mm(

Pyridoxine mg/L	Fulvic acid g/L				Mean
	0	0.5	1.0	1.5	
0	3.15 j	3.61 ghi	3.93 ef	4.21 abcd	3.72 C
50	3.43 i	3.65 ghi	4.00 de	4.24 abc	3.83 BC
100	3.48 hi	3.68 gh	4.05 cde	4.34 ab	3.89 AB
150	3.53 ghi	3.76 fg	4.12 bcde	4.43 a	3.96 A
Mean	3.40 D	3.68 C	4.02 B	4.31 A	

Table 4. Effect of spraying with different concentrations of pyridoxine and fulvic acid and their interaction on flower survival time on the plant (day(

Pyridoxine mg/L	Fulvic acid g/L				Mean
	0	0.5	1.0	1.5	
0	21.58 g	25.08 efg	28.42 cde	30.67 bcd	26.44 B
50	22.42 g	25.75 efg	29.08 bcde	32.67 abc	27.48 AB
100	23.17 g	26.00 defg	29.67 bcde	33.42 ab	28.06 AB
150	23.67 fg	28.17 cdef	30.50 bcd	35.17 a	29.38 A
Mean	22.69 D	26.25 C	29.42 B	32.98 A	

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Table 5. Effect of spraying with different concentrations of pyridoxine and fulvic acid and their interaction on fresh weight of the flower (g(

Pyridoxine mg/L	Fulvic acid g/L				Mean
	0	0.5	1.0	1.5	
0	7.85 h	9.59 fg	10.74 de	12.32 c	10.13 C
50	8.33 h	9.66 fg	11.07 d	12.58 c	10.41 C
100	9.17 g	9.86 fg	11.30 d	13.50 b	10.96 B
150	9.49 fg	10.09 ef	11.46 d	14.28 a	11.33 A
Mean	8.71 D	9.80 C	11.15 B	13.17 A	

Table 6. Effect of spraying with different concentrations of pyridoxine and fulvic acid and their interaction on dry weight of the flower (g(

Pyridoxine mg/L	Fulvic acid g/L				Mean
	0	0.5	1.0	1.5	
0	3.92 h	4.79 fg	5.37 de	6.16 c	5.06 C
50	4.16 h	4.83 fg	5.53 d	6.29 c	5.20 C
100	4.58 g	4.93 fg	5.65 d	6.75 b	5.48 B
150	4.74 fg	5.04 ef	5.73 d	7.14 a	5.66 A
Mean	4.35 D	4.90 C	5.57 B	6.58 A	

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