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Improvement Fresh Weight and Aerial Part Yield of Marigold (*Calendula officinalis* L.) by Humic Acid

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ABSTRACT

To study the effect of humic acid on yield and yield components of marigold, a complete randomized experiment with 5 levels of humic acid treatment (0, 500, 1000, 2000, 4000 mgl^{-1}) with 3 replications and 15 experimental plots was carried out. Analysis of variance showed that the effect of humic acid treatments on all measured traits was significantly at the 1% probability level. Mean comparisons revealed that treatment with 2000 mgl^{-1} humic acid, had the most flower number per plant, fresh weight and branches & nodes number.

Keywords: humic acid, *Calendula officinalis* L., fresh weight, nodes number

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INTRODUCTION

Marigold has about 20 species that two species *Calendula arvensis* & *Calendula officinalis* L.have medicinal application [6]. This plant is used to plants to treat diseases of the stomach, intestines, and also, the flowers extract is used to dye some types of foods and fats [10]. Most parts of Iran soils are arid and semi-arid with an alkaline pH and that's why they are in food shortage [8]. Indiscriminate use of chemical fertilizers, especially nitrogen, causes nitrate accumulation in soils and reduce the yield & quality and also plant toxicity which have irrecoverable risks for human life [7]. Indiscriminate use of chemical fertilizers destructs soil chemical and physical texture and in the long term, consequences will be irreversible which reduced plant yield [2, 7]. Use of humic acid and bio-fertilizers is proposed to modify soil texture, soil structure integrity, aeration and increase nutrient absorption [3, 8]. Abdel-Mawgoud et al. [1] investigated effects of humic acid and nitrogen, phosphorus & potassium fertilizers on tomato (*Lycopersicum esculentum*) and reported that the number of leaves, fresh and dry weight and internal hormones level increased as treated with this compound and caused production improvement and enhancement in fruits quality. The aim of this study is to investigate the effect of humic acid on fresh weight enhancement and increase aerial part's yield of marigold.

MATERIALS AND METHODS

Marigold seedlings (*Calendula officinalis* L.) are purchased from a greenhouse in Amol and were subjected to humic acid treatments (0, 500, 1000, 2000, 4000 mgl^{-1}) on the basis of complete randomized experimental design with 5 treatments in 3 replications and 5 seedlings per plot. In present study, number of nodes, number of branches, the most number of flowers per plant & fresh weight were recorded. Number of nodes and branches height encountered visually. The most number of flowers is also encountered visually based on the most number of flower

per plot, then the average between 3 replications were calculated & recorded as the most number of flowers per plant. At flowers harvest time (when the flowers were wilted and had lower marketable yields) plants were cut from the soil surface and fresh weight was measured with a digital scale with an accuracy of 0.01 g. Data were subjected to analysis of variance using SPSS and MSTATC software and mean comparisons was performed according to LSD test.

RESULTS AND DISCUSSION

Analysis of variance showed that the effect of humic acid treatments on all measured traits was significant at 1% probability level. Humic acid effect on nods number showed that treatment with 2000 mgl^{-1} was the best treatment (11.82 nods), and the control (6.61 nods) was the worst treatment. In present study, humic acid treatment increased nodes number which could be due to positive effect and also hormone-like activity of humic acid on the ability of these compounds as nutrient retention and storage [9, 11, 13]. Thi Lua & Bohme [16] found that use of humic acid from calcium humat source, increased calcium content in stems and aeration parts in tomato. Our results about the positive impact of humic acid on growth and yield improvement of aeration parts is also in consistent with Dogan & Demir [5]. Humic acid effect on the number of branches showed that treatment with 2000 mgl^{-1} with 14.30 branches are the most effective treatment as compared to the control (5.84 branches). The positive effect of humic acid can also be due to the absorption of nutrients which enhances the yield of micro and macro elements which affects shoots yield [4]. Singh et al. [15] studied on calendula (*Calendula officinalis* L.) and found that the use of bio-fertilizers improved yield and yield-related indexes. Mean comparison about humic acid effect on fresh weight showed that between different levels of humic acid, those which treated with 2000 mgl^{-1} 284.69 g fresh weight was the most effective treatment and control with 195.11 g mg was the worst treatment. In present study, humic acid is known as proper fertilizer which increases fresh weight, it can be attributed to improved nutrient uptake by roots which ultimately resulted in growth and yield enhancement. Our results about the effect of humic acid on nutrient absorption enhancement are in accordance with Thi Lua & Bohme [16] Salman et al. [11] Siam et al. [14] and Singh et al. [15]. Saruhan et al. [12] investigated the effects of different fertilizer treatments on the yield of bean (*Vicia faba*) and found that humic acid increases plant biomass. Effect of humic acid on flowers number showed that treatment with 2000 mgl^{-1} with 31.83 flowers was the most effective treatment as compared to the control (19.25 flowers).

In present study, humic acid had positive impact on yield and flowers number which could be due to the positive influence of humic compounds on nutrients absorption, and this ultimately increases the number of flowers [13]. Nikbakht et al. [9] reported that 500 mgl^{-1} humic acid caused a 52% yield increase gerbera flowers (*Gerbera Jamesonii* L.), this results coincide with the results of our study. Present study showed that 2000 mgl^{-1} humic acid significantly increased fresh weight's and aeration part's yield of marigold (*Calendula officinalis* L.).

Table 1 . Effect of humic acid on the measured traits of marigold (*Calendula officinalis* L.)

Treatments	Nodes number	Branches number	Fresh weight (g)	The most flower number per plant
H_1	6.61c	5.84c	195.11c	19.25d
H_2	9.22b	10.45b	234.70b	26.91bc
H_3	9.92b	11.66b	250.89b	28.91ab
H_4	11.82a	14.30a	284.69a	31.83a
H_5	9.42b	10.14b	228.50b	23.25c

H_1: control; H_2: 500 mgl^{-1} humic acid; H_3: 1000 mgl^{-1} humic acid; H_4: 2000 mgl^{-1} humic acid; H_5: 4000 mgl^{-1} humic acid. In each column, means with a common letter are significant based on the DMRT test.

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