

# The effect of biological and chemical fertilizers on yield of *Calendula officinalis* in greenhouse conditions

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**ABSTRACT:** *Calendula officinalis* is one of the most important medicinal plants. To investigate the effects of biological and chemical fertilizers on yield of *Calendula officinalis*, an experiment was conducted on the basis of randomized complete blocks design in four replicates at Iranian of Islamic Azad University Branch Tabriz. The fertilizer treatments in three levels (Nitroxine, Urea, Nitroxine fertilizer + Urea fertilizers) and control or no fertilizers. The results showed that the effect of biological and chemical fertilizers was significant ( $P < 0.01$  and  $P < 0.05$ ) on all of parameters (plant height, stem diameter, essential oil, total fresh weight and total dry weight). The maximum plant height, stem diameter, essential oil, total fresh weight and total dry weight were obtained by Nitroxine fertilizer + Urea fertilizer treatment. The least parameters were observed by control treatment.

**Keywords:** *Calendula officinalis*, biological, chemical, essential oil.

## INTRODUCTION

*Calendula officinalis* (pot marigold, ruddles, common marigold, garden marigold, English marigold, or Scottish marigold)[1] is a plant in the genus *Calendula* of the family Asteraceae. It is probably native to southern Europe, though its long history of cultivation makes its precise origin unknown, and it may possibly be of garden origin. It is also widely naturalised further north in Europe (north to southern England) and elsewhere in warm temperate regions of the world (Ukiya, 2006).

*Calendula officinalis* is a short-lived aromatic herbaceous perennial, growing to 80 cm (31 in) tall, with sparsely branched lax or erect stems. The leaves are oblong-lanceolate, 5–17 cm (2–7 in) long, hairy on both sides, and with margins entire or occasionally waved or weakly toothed. The inflorescences are yellow, comprising a thick capitulum or flowerhead 4–7 cm diameter surrounded by two rows of hairy bracts; in the wild plant they have a single ring of ray florets surrounding the central disc florets. The disc florets are tubular and hermaphrodite, and generally of a more intense orange-yellow colour than the female, tridentate, peripheral ray florets. The flowers may appear all year long where conditions are suitable. The fruit is a thorny curved achene (Jump up, 2001).

Organic agriculture is an integrated system of agriculture based on ecological principles. Chemical fertilizers, pesticides and growth regulators are not applied in this system and crop rotation with legume family of plants, plant debris, manure, rocks containing mineral nutrients, organic fertilizers and biological pest control are applied, instead, so that along with biodiversity development in farms (Wallace, 2001 & Elsen, 2000), the nutrients in the soil are deposited, the soil fertility is increased and weeds, insects and pests are controlled (FAO, 2002). Compost and organic fertilizers are applied for improving soil fertility and also prevention and control of plant pests and diseases, in many agricultural systems (Barker and Bryson, 2006 & Ghorbani, 2006).

Plant growth promoting rhizobacteria (PGPR) are a group of bacteria that can actively colonize plant roots and increase plant growth. These PGPR can prevent the deleterious effects of phytopathogenic organisms and stressors from the environment. The *Bacillus* sp. Strains enhance soybean nodulation and growth under low temperature stress. PGPR produce plant growth promoting compounds including phytohormones; auxins, cytokinins and gibberellins,

as well as siderophores, and antibacterial peptides that inhibit pathogenic strains . It has been recently shown that plants will respond to rather unconventional bacterial signal compounds, such as quorum sensing molecules and volatile compounds. Bacterial volatiles may have a significant role in plant growth promotion , as an increase in Arabidopsis growth has been attributed to a number of airborne bacterial chemicals. Bacteria have developed diverse resistance strategies towards toxic minerals. Hasnain and Sabri (1996) reported that inoculation of wheat with *Pseudomonas* sp. stimulated plant growth by reduction of toxic ion uptake, increases in auxin contents and formation of stress-specific proteins in plants under stress caused by the toxic ion.

Little is known about the co-inoculation of *Bacillus lentus* and *Pseudomonades* sp and their effect on the antioxidant status and photosynthesis of basil under different conditions of soil salinity. In this paper, we report a detailed study of the effect of long-term stress due to salinity on the mineral content, photosynthesis and antioxidant level of basil. An additional objective was to determine the possible importance of combining *Bacillus lentus* and *Pseudomonades* sp for plant tolerance to soil salinity conditions and to define the possible mechanisms involved (Vivas, 2003).

The aim of this study was to investigate the effect of biological and chemical fertilizers on yield of *Calendula officinalis* in greenhouse conditions.

### MATERIALS AND METHODS

This experiment was carried out in 2013-2014 at Iranian of Islamic Azad University, Branch Tabriz. The soil s loam-silt with 0.071% N, 48.9 mg.kg<sup>-1</sup> Phosphorous, 33.6 mg.kg<sup>-1</sup> Potassium, EC 2.71 ds.m<sup>-1</sup>, and pH 8.3.

This study has been conducted on the base experiment in randomized complete block design with 4 treatments and 4 replications. The treatments were in three levels (Nitroxine, Urea, Nitroxine fertilizer + Urea fertilizers) and control or no fertilizers.

Twenty seeds were sown at each pot and after thinning, 5 plants were remained in each pot. All operations were done regularly during the growing season. The studied parameters were: plant height (cm), stem diameter (mm), yied of stem fresh weight (kg.ha<sup>-1</sup>), the total dry weight (g), the total fresh weight (g) essential oil (m liter).

In order to measure total dry matter, the five plants from each pot were harvested and then were placed in the electric oven of 75° C until the constant weight was gained. Determination of essential oils was achieved by using a combination of the well tested Gas Chromatography analysis (GC) method described by Jankovsky . (1989) and the Continuous Distillation Extraction (CDE) method after Jankovsky . (1993).

Analysis of variance of the results was done using the SPSS software (ver.17), and means in the results were compared using the Fisher's protected Least Significant Differences (LSD) Test.

### RESULTS AND DISCUSSION

#### RESULTS

Effect of biological and chemical fertilizers on plant height, stem diameter, essential oil, total fresh weight and total dry weight was statistically significant (P<0.05) (Table 1). The results indicated that the maximum plant height (35.9 cm) was obtained by Nitroxine fertilizer + Urea fertilizers treatment (T4). The least plant height (32.5 cm) was observed by control treatment (Table 2).

Table 1. Source of variance for growth traits and yield of *Calendula officinalis*

Source of variance	d.f.	plant height	Stem diameter	Dry width	Fresh width	essential oil
block	3	5.74 <sup>ns</sup>	0.44 <sup>ns</sup>	0.21 <sup>ns</sup>	1.07 <sup>ns</sup>	0.0002 <sup>ns</sup>
Treatment	3	10.14 <sup>*</sup>	0.14 <sup>**</sup>	0.34 <sup>**</sup>	5.12 <sup>**</sup>	0.0684 <sup>**</sup>
Error	9	2.44	0.10	0.01	1.13	0.0037

ns, \*and \*\*: not significant, significant at the 5% and 1% probability levels, respectively

Moreover, these results are according to Karima & Abdel Wahed (2005). They reported that use of biological and chemical fertilizers significantly increased height of German chamomile. Abou Dahab & Abd El-Aziz (2006) suggested that use of PGPR were significantly effective on height of philodendron so that in 1st and 2<sup>nd</sup> year, the height of samples increased from 25.60 cm to 46.30 cm and from 27.30 cm to 47.30 cm, respectively.

Table 2. Mean squares for growth traits and yield of *Calendula officinalis*

Treatment	plant height	Stem diameter	Dry width	Fresh width	essential oil
T1	32.5 c	0.4 b	40 c	101 c	0.28 c
T2	34 b	0.8 b	66 b	131 b	0.36 b
T3	34.4 b	0.9 b	68 b	136 b	0.38 b
T4	35.9	1.6 a	90 a	171 a	0.49 a

Means with similar letter are not significant at the 5% probability level

The effects of biological and chemical fertilizers ( $P < 0.05$ ) on stem diameter were significant (Table 1). The most stem diameter (1.6mm) was obtained by T4 treatment and The least stem diameter (0.4 cm) was observed by control treatment (Table 2). Then results of this study are according to Mazher ., 2011 on *Codiaeum variegatum* L., Farooqi . 1996 on *Artemisia annua* L.

The concerning interaction effect of humic acid and amino acid in isolation and in presence of chelated micro nutrients and the results by Shekari ., 2012 on *Plantago psyllium* L. with bio-stimulator spray. Increase in yield and growth parameters is proved to be feasible using amino acids. Therefore, supply of nutritious sources to form protein tissue is essential (Neeraja ., 2005).

These results are in line with Nahed ., 2009 study on use of amino acids tirozin, thiamin and tryptophan on *Thuja Orientalis* L. They concluded that all growth parameters improved with increase in concentration of amino acids.

Positive effect of amino acids on plant performance might be due to stimulating effect of amino acids on plant cells growth. However, amino acids were introduced by Goss, 1973 as a source of energy during lack of carbohydrates. These results are in according to Christopher ., 2007 on *Basella rubra* L. They reported that application of bio-fertilizers increased stem diameter, secondary stem number, leaves number.

The quantitative determination of essential oils in the *Calendula officinalis* were carried out, using the aforementioned techniques, on leaves after drying in the thermostat dryer. Table 2 shows the detailed results obtained for each treatment. The T4 treatment gave highest amount of essential oil.

The above data show that all the exogenously supplied regulators of plant growth and development triggered increase in the accumulation of essential oils in *Calendula officinalis*. Another significant and interesting finding regarding the influence of the used exogenous regulators of plant growth and development was registered on the constitution of the essential oils in *Calendula officinalis*.

According to variance analysis, effects of biological and chemical-fertilizers were significant ( $P < 0.01$ ) on total dry weight (Table 2). The results indicated that the maximum total dry weight (90 g) was obtained by T4 treatment . The minimum total dry weight (40 g) was observed by control treatment (Table 2). These results are according to Dino ., 2009 study on application of perfectoz bio-stimulator on pepper. Also, Rafiee ., 2011 reported that application of bio-stimulators increased total dry weight of Pot marigold seedlings.

Biological and chemical-fertilizers had significant ( $P < 0.01$ ) effect on leaf fresh weight, stem fresh weight total fresh weight (Table 1). The maximum total fresh weight (543.2 kg.ha<sup>-1</sup>) was obtained by 1.5 fosnutren. The minimum total fresh weight (171 g) was observed by application of T4 treatment (Table 2). In an experiment, Sanchez ., 2005 reported that application of biological fertilizers could increase yield of *Matricaria recutita*.

## DISCUSSION

The results on plant average height showed significant differences between plants from different treatments, especially between the control plants and plants sprayed with the biological fertilizers of plant growth and development.

The above results on plant height confirmed that all the exogenous regulators used in this research supported increase in plant height and stem elongation. This result is consistent with the work on *Calendula officinalis* where the plant growth regulator Gibberellic Acid (GA) increased plant height, length of internodes, leaf area and biomass. However the use of Cycocel had a negative effect on the above parameters (Umesha ., 1991). Further, the work on *Calendula officinalis* supports the results of this study on the role of growth regulators in increasing plant height and number of leaves per plant (Shedeed ., 1990).

The control plants had the highest number of branches the yields of *Calendula officinalis* are in a wide range,

## CONCLUSION

In this experiment, commercial formulation of biological and chemical fertilizers had significantly positive effect on growth parameters of *Calendula officinalis*. In interaction effects biological and chemical fertilizers improved vegetative and reproductive traits. In general, these compounds can be supply essential nutrients like nitrogen, phosphorous and potassium and affect on morphological growth of the plant.

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