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Morphological traits of sweet basil (*Ocimum basilum* L.) as influenced by foliar application of methanol and nano-iron chelate fertilizers

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ABSTRACT

To investigate the effects of nano-iron chelate fertilizer and different concentration of methanol on morphological traits of sweet basil (Ocimum basilum L.), an experiment was carried out at the Research farm of Institute of Medicinal Plants, ACECR. A factorial experiment based on randomized complete design (RCD) with three replications was followed in this study. Results showed that morphological traits were significantly affected by different concentration of methanol and nano-iron chelate fertilizer. The lowest plant height was obtained by utilization of nano-iron chelate fertilizer at 0.5 g.l^{-1} concentration together with methanol at 20% concentration and application of methanol at 20% concentration lonely. Different concentrations of methanol and interaction between nano-iron chelate fertilizer and methanol at different concentrations had significant effects on number of branches per plant. There wasn't significant difference between utilization of methanol at 30% and 20% concentration in respect of leaf number and the highest leaf number was obtained by these treatments. Application of nano-iron chelate fertilizer at 0.5, 1 and 1.5 g.l^{-1} concentration had similar effects on leaf number and the highest of leaf number was gained by these treatments. However the lowest leaf number was observed in non-application of nano-iron chelate fertilizer.

Keywords: *Ocimim basilicum* L., morphological traits, nano-iron chelate fertilizer, methanol concentration, foliar fertilizers.

INTRODUCTION

Ocimum basilicum L. (Lamiaceae), respectively, named basil, is an aromatic plant. The genus *Ocimum* (Lamiaceae) consists of about 50–150 species (Simon *et al*., 1990) with a large number of varieties containing both terpene and non-terpene constituents in their essential oils (Evans, 1995). Basil has a long history as culinary herb, thanks to its foliage which adds a distinctive flavor to many foods. Essential oil extracted from *O. basilicum* L. has antioxidative, antimicrobial activity (Javanmardi *et al*., 2003). It is also considered as a source of aroma compounds, and it possesses a range of biological activities such as insect repellent, nematocidal, antifungal agents and antioxidants activities (Lee *et al*., 2005; Deshpande and Tipnis, 1977; Simon *et al*., 1999; Juliani and Simon, 2002). McClatchey (1996) mentioned leaves of *O. basilicum* L. suitable for treatment of pain and cough.

Micronutrients play an important role in the production and productivity. Among micronutrients, Iron (Fe) is a cofactor for approximately 140 enzymes that catalyze unique biochemical reactions (Brittenham, 1994). Singh and Dayal (1992) reported that spraying iron would cause a 38-42% increase in the peanut yield in alkaline soils.

According to some of the researches, use of foliar spraying of iron fertilizer (sulphate of iron) had significant effect on seeds per head and seed yield of safflower genotypes (Zareie *et al.*, 2011). The aims of this research were assessment of relationships among morphological traits and foliar application of different concentration of nano-iron chelate fertilizer and methanol.

MATERIALS AND METHODS

This experiment was carried out in 2011-2012 at the at the Research farm of Institute of Medicinal Plants, ACECR (56°35´N and 50°58´E; 1500 elevation). This study was done on the base of factorial experiment in randomized complete design with three replications. The treatments included methanol concentrations in 5 levels: 0, 10, 20, 30 and 40% (v/v) together with 4 levels of nano-iron chelate fertilizer concentrations: 0, 0.5, 1 and 1.5 $g.l^{-1}$ (foliar spraying) were conducted in this experiment. Fifteen seeds were sown at each pot. All of the treatments were sprayed in four stages including: two leaf stages (3 weeks after sowing), 6 leaf stages (spraying a week after first time of spraying), spraying a week after six leaf stages and spraying in flowering stages. All operations were done regularly during the growing season. In order to measure total dry matter, some plants were selected randomly from each pot and then were placed in the electric oven of 75° C until the constant weight was gained. Morphological characteristics including plant height, number of branches per plant, leaf number, stem diameter, flower dry weight were determined. Data analysis was done by using SAS. The ANOVA test was used to determine significant ($p\leq 0.01$ or $p\leq 0.05$) treatment effect and Duncan Multiple Range Test to determine significant difference between individual means.

RESULTS AND DISCUSSION

Plant height

Results showed that plant height wasn't significantly affected by different concentrations of nano-iron chelate fertilizer and methanol. However, interaction between treatments had significant effect on this morphological trait (Table 1). Means comparison of interaction between application of nano-iron chelate fertilizer together with different concentration of methanol (Table 3) showed that however different concentration of nano-iron chelate fertilizers (0.5, 1 and 1.5 $g.l^{-1}$) lonely had similar effects on plant height but maximum of plant height was gained by utilization of nano-iron chelate fertilizer at 0.5 $g.l^{-1}$ concentration together with methanol at 30% concentration. The lowest plant height was obtained by utilization of 0.5 $g.l^{-1}$ nano-iron chelate fertilizer together with methanol at 20% concentration and application of methanol at 20% concentration lonely. With out spraying methanol, nano-iron chelate fertilizer at 0.5, 1 and 1.5 $g.l^{-1}$ concentration had similar effects on plant height (Table 3).

Table 1. Analysis of variance for measured traits in sweet basil (*Ocimum basilicum* L).

S.O.V	DF	Plant height	Number of branches per plant	Leaf number	Stem diameter	Flower dry weight
Methanol (M)	4	5.005^{ns}	2.89^{**}	25.616^{*}	0.044^{ns}	0.050^{*}
Nano-iron chelate fertilizer (N)	3	17.905^{ns}	1.013^{ns}	26.110^{*}	0.105^{*}	0.136^{**}
M × N	12	35.106^{**}	1.509^{**}	0.314^{ns}	0.038^{ns}	0.038^{*}
Error	40	7.719	0.432	7.120	0.027	0.015
CV	-	10.04	17.52	15.91	11.57	12.02

^{ns} = Non significant, ** = $p < 0.01$, and * = $p < 0.05$.

Table 2. Means comparison of effects of nano-iron chelate fertilizer and methanol treatments on morphological traits of sweet basil (*Ocimum basilicum* L).

treatments		Plant height (cm)	Number of branches ($No.plant^{-1}$)	Leaf number (No.)	Stem diameter (mm)	Flower dry weight ($g.plant^{-1}$)
Different concentration of Methanol (M)	Non-application (M_1)	26.80^{a}	3.15^{c}	15.26^{b}	1.36^{b}	0.93^{b}
	10% (M_2)	27.34^{a}	3.54^{bc}	16.04^{b}	1.39^{ab}	0.95^{b}
	20% (M_3)	27.75^{a}	3.70^{bc}	17.26^{ab}	1.44^{ab}	0.96^{b}
	30% (M_4)	28.55^{a}	3.88^{b}	19.05^{a}	1.51^{a}	1.10^{a}
	40% (M_5)	27.81^{a}	4.49^{a}	16.23^{b}	1.39^{ab}	0.98^{b}
Different concentration of Nano-iron chelate fertilizer (N)	Non-application (N_1)	26.74^{b}	3.44^{b}	14.89^{b}	1.30^{b}	0.88^{c}
	0.5 $g.l^{-1}$ (N_2)	27.50^{ab}	3.92^{ab}	16.92^{a}	1.47^{a}	0.99^{b}
	1 $g.l^{-1}$ (N_3)	29.22^{a}	4.01^{a}	17.94^{a}	1.49^{a}	1.11^{a}
	1.5 $g.l^{-1}$ (N_4)	27.15^{ab}	3.64^{ab}	17.32^{a}	1.41^{ab}	0.96^{bc}

Number of branches per plant

Table 1 showed that different concentrations of methanol and interaction between nano-iron chelate fertilizer and methanol at different concentrations had significant effect on number of branches per plant however effect of nano-iron chelate fertilizer treatments on this parameter wasn't significant. According to means comparison of different concentration of methanol treatments (Table 2), the highest number of branches per plant was gained by application of methanol at 40% concentration. The lowest branches number was obtained by non-application of methanol treatments (control). The methanol at 10, 20, and 30% concentration had similar effects on this parameter (Table 2). Means comparison of interaction between treatments indicated that there wasn't significant difference between utilization of nano-iron chelate at 0.5 and 1 $g.l^{-1}$ concentration together with methanol at 40% concentration on number of branches per plant and maximum of branches number was obtained by these treatments (Table 3). The lowest of branches number was gained by application of nano-iron chelate fertilizer at 0.5 $g.l^{-1}$ concentration lonely and non-application of nano-iron chelate fertilizer and methanol treatments.

Leaf number

Results indicated that leaf number was significantly affected by application of nano-iron chelate fertilizer and different concentration of methanol treatments and interaction between treatments wasn't significant (Table 1). According to means comparison between different concentration of methanol on leaf (Table 2), application of methanol treatments had significant effect on leaf number but there wasn't significant difference between utilization of methanol at 30 and 20% concentration on leaf number and the highest leaf number was obtained by these treatments. Means comparison between nano-iron chelate treatments (Table 2) on leaf number indicated that application of nano-iron chelate fertilizer at 0.5, 1 and 1.5 $g.l^{-1}$ had similar effects on leaf number and the highest of leaf number was gained by these treatments however the lowest leaf number was observed by non-application of nano-iron chelate fertilizer (control).

Table 3. Means comparison of interaction between nano-iron chelate fertilizer and methanol treatments on morphological traits of sweet basil (*Ocimum basilicum* L).

Interaction between treatment methanol (m)×nano-iron chelate fertilizer (n)		Plant height (cm)	Number of branches ($No.plant^{-1}$)	Leaf number (No.)	Stem diameter (mm)	Flower dry weight ($g.plant^{-1}$)
Non-application (M_1)	Non-application (N_1)	24.73^{cde}	2.80^{d}	13.2^{c}	1.27^{b}	1.01^{bc}
	0.5 $g.l^{-1}$ (N_2)	28.06^{bcd}	2.50^{d}	18.08^{abc}	1.53^{ab}	0.9^{bcd}
	1 $g.l^{-1}$ (N_3)	25.29^{bcde}	3.73^{bcd}	13.65^{c}	1.24^{b}	1.06^{bc}
	1.5 $g.l^{-1}$ (N_4)	29.13^{bc}	3.60^{bcd}	16.10^{abc}	1.41^{b}	0.76^{d}
10% (M_2)	Non-application (N_1)	26.35^{bcde}	3.73^{bcd}	15.33^{abc}	1.31^{b}	0.83^{cd}
	0.5 $g.l^{-1}$ (N_2)	27.5^{bcd}	2.90^{cd}	15.44^{abc}	1.47^{ab}	1.02^{bc}
	1 $g.l^{-1}$ (N_3)	30.24^{ab}	4.20^{bc}	17.54^{abc}	1.48^{ab}	1.00^{bcd}
	1.5 $g.l^{-1}$ (N_4)	25.28^{bcde}	3.33^{bcd}	15.86^{abc}	1.29^{b}	0.96^{bcd}
20% (M_3)	Non-application (N_1)	30.26^{ab}	3.70^{bcd}	13.85^{c}	1.26^{b}	0.83^{cd}
	0.5 $g.l^{-1}$ (N_2)	22.07^{e}	3.70^{bcd}	18.09^{abc}	1.53^{ab}	1.03^{bc}
	1 $g.l^{-1}$ (N_3)	30.22^{ab}	3.70^{bcd}	20.22^{ab}	1.57^{ab}	1.03^{bc}
	1.5 $g.l^{-1}$ (N_4)	28.45^{bcd}	3.70^{bcd}	16.87^{abc}	1.39^{b}	0.96^{bcd}
30% (M_4)	Non-application (N_1)	23.64^{de}	3.36^{bcd}	17.42^{abc}	1.36^{b}	0.86^{bcd}
	0.5 $g.l^{-1}$ (N_2)	34.68^{a}	4.20^{bc}	18.03^{abc}	1.53^{ab}	1.00^{bcd}
	1 $g.l^{-1}$ (N_3)	30.08^{abc}	4.16^{bc}	20.53^{a}	1.73^{a}	1.43^{a}
	1.5 $g.l^{-1}$ (N_4)	25.81^{bcde}	3.80^{bcd}	20.22^{ab}	1.44^{ab}	1.10^{b}
40% (M_5)	Non-application (N_1)	28.72^{bcd}	3.63^{bcd}	14.66^{c}	1.32^{b}	0.89^{bcd}
	0.5 $g.l^{-1}$ (N_2)	25.18^{bcde}	6.30^{a}	14.97^{bc}	1.29^{b}	1^{bcd}
	1 $g.l^{-1}$ (N_3)	30.28^{ab}	4.26^{b}	17.76^{abc}	1.43^{ab}	1.04^{bc}
	1.5 $g.l^{-1}$ (N_4)	27.08^{bcde}	3.76^{bcd}	17.54^{abc}	1.52^{ab}	1.00^{bcd}

Stem diameter

The results in the Table 1 indicated that different concentration of nano-iron chelate fertilizer had significant effect on stem diameter and utilization of methanol and interaction between treatments wasn't significant. Means comparison between different concentrations of nano-iron chelate treatments represented that application of nano-iron chelate fertilizer at 1 and 1.5 g.l^{-1} concentrations had similar effects on stem diameter and maximum of this morphological trait was obtained by these treatments (Table 2).

Flower dry weight

Results showed that flower dry weight was significantly affected by different concentration of methanol and nano-iron chelate fertilizer treatments and interaction between treatments was significant (Table 1). According to means comparison of methanol at different concentration on flower dry weight (Table 2), application of methanol treatments at 10, 20 and 40% had similar effects on flower dry weight and the lowest flower dry weight was gained by non-application of methanol. The highest flower dry weight was obtained by application of methanol at 30% concentration. Means comparison between nano-iron chelate fertilizers indicated that the highest and lowest flower dry weight was gained by utilization of nano-iron chelate fertilizer at 1 g.l^{-1} concentration and non-application of nano-iron chelate fertilizer treatments (Table 2). Means comparison of interaction between treatments (Table 3) represented that maximum of flower dry weight was gained by utilization of nano-iron chelate fertilizer at 1 and 1.5 g.l^{-1} concentrations together with methanol at 30% concentration. The lowest flower dry weight was witnessed by application of nano-iron chelate fertilizer at 1.5 g.l^{-1} concentration lonely.

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