Study of Effects of different levels of irrigation interval and nitrogen on some physiological traits of signet marigold (*Tagetes tenuifolia*)

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Abstract: In order to study the effect of different levels of irrigation and nitrogen on some physiological traits of signet marigold (*Tagetes tenuifolia*), a study was carried out in greenhouse of Ferdowsi University of Mashhad, Iran in 2012 on the basis of a Randomized Complete Block Design with three replications. The main plot was irrigation interval at three levels of 2, 4 and 6 days and the sub-plot was N fertilization at three levels of 0, 15 and 30 g. Analysis of variance showed that the effect of irrigation interval was not significant on chlorophyll index, stomatal conductance and leaf area. N fertilization level significantly influenced total leaf area, but its effect was not significant on chlorophyll index and stomatal conductance, so that the increase in N fertilization level significantly increased total leaf area by 3.8%. So, it is recommended to use irrigation interval of 2 days and 30 g N fertilization to achieve the highest level of the studied physiological traits.
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Introduction

Signet marigold (*Tagetes tenuifolia*) is an annual, erect and fast-growing plant with dark green, glossy and aromatic leaves which have deep recesses. It belongs to the family of Asteracea. It is used as cut flower, pot flower, or border (Ghasemi Ghahsari and Kafi, 2006). Signet marigold is cold-sensitive and heat and drought-resistant. Its large, petaled flowers appear in yellow and a range of orange color in summer. It reaches to the maximum height of 60 cm and spreads in an area of 30-40 cm.

Iran is characterized with hot, arid climate. Most parts of this country are arid and semi-arid with low annual precipitation which has inappropriate temporal and special distribution too, so that even showery regions of this country need irrigation in summer and sometimes, despite high moisture availability in root zone, transpiration rate exceeds water uptake rate due to low relative humidity of the atmosphere, high temperature and high mean wind speed (Sarmadnia and Koucheki, 1997). Therefore, water saving is beyond question. On the other hand, irrigation is one of the most costly parts of pot flowers production and maintenance. In a pot study on growth indices of five medicinal herbs under different drought stress conditions, Lebaschi and Sharifi Ashourabadi (2004) stated that the studied herbs had different responses to stress. Sage and yarrow had the best growth under drought treatments and exhibited perfect growth under these conditions.

In a study on South American marigold under hot, semi-arid conditions of India, the application of 200 kg N.ha-1 was found to be the best treatment for achieving the highest herbage yield (Singh and Ganesha Rao, 2005) which was in agreement with the results of Singh (2001) for hot, semi-arid regions of Southern India.

Bredemeier (2005) reported that the highest chlorophyll index was observed at the highest N fertilization level. Given these facts, the objective of the current study was to examine the effect of different N fertilization levels at different irrigation intervals on some physiological traits of signet marigold.

Materials and Methods

The study was carried out in greenhouse of Ferdowsi University of Mashad, Iran in 2012 on the basis of a Randomized Complete Block Design with three replications. The main plot was irrigation interval at three levels of 2, 4 and 6 days and the sub-plot was N fertilization at three levels of 0, 15 and 30 g. The seeds of signet marigold were sown in greenhouse eight weeks before transplanting. When the seedlings had four leaves, they were transferred to pots, so that each pot included 10 transplants.

N fertilizer was applied from urea source at two stages (4-leaf and pre-flowering stage). Chlorophyll index was measured by SPAD-502.

Total leaf area was measured by leaf area meter in terms of cm. Also, stomatal conductance of the leaves was assessed by prometer in terms of mol.m-2.s-1. The collected data were statistically analyzed

by MS-TATC software and the means were compared by Duncan Test at 5% level.

Results and Discussion

Chlorophyll index

Chlorophyll index was affected by none of the studied simple effects and the interactions (Table 1). Nonetheless, means comparison for this trait under different N fertilization levels revealed that this index was increased with N level, so that the highest N fertilization level resulted in the highest chlorophyll index (on average, 33.756) (Table 2).

Stomatal conductance

Analysis of variance showed that none of the simple effects and the interactions affected stomatal conductance (Table 1). However, the highest stomatal conductance (on average, 0.146 mol.m-2.s-1) was obtained from the irrigation interval of 2 days (Table 2).

Total leaf area

The effect of N fertilization level and the interaction between irrigation and N fertilization was significant for total leaf area at 5% statistical level, but irrigation did not impact it significantly (Table 1). The highest total leaf area (on average, 5362.978 cm2) was obtained from the plants treated with no N fertilizer and the increase in N level up to 30 g decreased it by 3.8% (Table 2).

Means comparison revealed that the irrigation interval of 2 days without the application of N fertilizer resulted in the highest total leaf area (on average, 5417.633 cm2) and the irrigation interval of 6 days treated with 30 g N produced the lowest one (on average, 5044.466 cm2) (Table 3).

Table 1. Results of analysis of variance for the effect of different levels of irrigation interval and N fertilization on some physiological traits of signet marigold

Sources of variation	Degree of freedom	Chlorophyll index	Stomatal conductance ($mol.m^{-2}.s^{-1}$)	Total leaf area (cm^2)
Replication	2	1.268^{ns}	0.0001^{ns}	6282.341^{ns}
Irrigation	2	6.141^{ns}	0.0001^{ns}	11234.236^{ns}
First error	4	1.034	0.0001	13660.556
N	2	16.308^{ns}	0.002^{ns}	93389.380^{*}
N × irrigation	4	5.531^{ns}	0.0001_{ns}	61367.940^{*}
Second error	12	7.322	0.001	15842.420
Coefficient of variation (%)		8.40	21.94	2.39

ns and * show non-significance and significance at 5% level, respectively.

Table 2. Means comparison for the effects of irrigation interval and N

Treatment	Chlorophyll index	Stomatal conductance ($mol.m^{-2}.s^{-1}$)	Total leaf area (cm^2)
Irrigation interval (day)			
2	32.022 ab	0.146 a	5279.233 a
4	33.144 a	0.132 a	5219.011 a
6	31.533 b	0.137 a	5281.133 a
N (g)			
0	31.744 a	0.128 a	5362.978 a
15	31.200 a	0.154 a	5257.100 ab
30	33.756 a	0.132 a	5159.300 b

Means of traits with similar letter(s) on each column did not have significant differences at 5% level.

Table 3. Means comparison for the interactions between irrigation interval and N

Irrigation interval (day)	N level (g)	Chlorophyll index	Stomatal conductance ($mol.m^{-2}.s^{-1}$)	Total leaf area (cm^2)
2	0	30.533 c	0.140 a	5417.633 a
	15	32.000 abc	0.160 a	5113.633 c
	30	3.533 ab	0.137 ab	5306.433 ab
4	0	34.200 a	0.107 b	5267.500 b
	15	30.567 c	0.160 a	5262.533 b
	30	34.667 a	0.130 ab	5127.000 c
6	0	30.500 c	0.137 ab	5403.800 ab
	15	31.033 bc	0.143 a	5395.133 ab
	30	33.067 abc	0.130 ab	5044.466 c

Means of traits with similar letter(s) on each column did not have significant differences at 5% level.

Conclusion

In total, it can be concluded that supplying adequate water and nitrogen can significantly increase the durability of signet marigold by improving its chlorophyll index, stomatal conductance and leaf area. So, it is recommended to use irrigation interval of 2 days and 30 g N fertilization to have long durability of this flower under the conditions of the current study.

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