



Effect of foliar application of zinc and salicylic acid on growth, flowering and chemical constitute of African marigold cv. pusa narangi gainda (*Tagetes erecta* L.)

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Abstract: A field experiment on African marigold (*Tagetes erecta* L.) was conducted during winter season of 2014-15 to study the foliar effect of Zn and SA of 20 treatment combinations having five concentrations of zinc (0.0, 0.25, 0.50, 0.75, and 1.0 %) and salicylic acid (0.0, 0.25, 0.50 and 1.0 mM/L). The treatment Zn₄SA₃ (Zinc 1% + Salicylic acid 1.0 mM/L) recorded the maximum plant height (77.41 cm), number of leaves per plant (314.10), earliest first flower bud appearance (39.78 days), maximum number of flowers per plant (62.33), maximum chlorophyll content (3.83mg/g) and maximum carotene content (3.07 mg/g) as compared to control where it was recorded minimum. These results are conclusive that foliar spraying with zinc 1.0% + salicylic acid 1.0 mM/L may positively increase the growth and flowering parameters of marigold.

Keywords: African marigold, Pusa narangi gainda, Salicylic acid, Zinc

INTRODUCTION

African marigold (*Tagetes erecta* L.) belongs to family Asteraceae is a very popular commercial flower crop as loose flower in India because of its wide adaptability to various soils, climatic conditions and easy cultivation. Marigold having ornamental, medicinal and industrial uses, it has additional use in controlling the soil nematodes. All varieties of marigold are resistant against root knot nematode, *Meloidogyne incognita* and could be used to control *M. incognita* in highly infested areas (Visser and Vythiunga, 1959; Natarajan et al., 2006). It is established fact that nutrition plays an important role in the improvement of growth, flowering and chemical constitute in marigold (Jayalakshmi et al., 2010). It is well known that Zinc acts as a co-factor of many enzymes and affects many biological processes such as photosynthetic reactions, nucleic acids metabolism, protein and carbohydrate biosynthesis. The role of Zinc in plant is due to its requirement in the synthesis of tryptophan which is a precursor of indole acetic acid (Shukla et al., 2009) and also activate the plant defense mechanism (Anuprita et al., 2005; Raut et al., 2014; Keram et al., 2014). The word salicylic acid (SA) was derived from Latin word "Salix", meaning willow tree. It is ubiquitously distributed in the whole plant kingdom and is classified under the group of plant hormones (Raskin et al., 1990). Exogenous application of Salicylic acid before reproductive stage may result in higher biomass production, disease resistant elicitors and increase in total flavonoids content of marigold plants.

Foliar application constitute the most effective means of micro-nutrient applications when problem of nutrient fixation in the soil exists. Therefore keeping this in view, the present experiment was initiated with an objective to study the effect of Zn and SA on flowering and yield of African marigold cv. Pusa Narangi Gainda to work out optimum dose of Zn and SA.

MATERIALS AND METHODS

The field experiment was carried out at the Instructional Farm, Krishi Vigyan Kendra, Jhalawar, during rabi season 2014-15. The soil had organic carbon 0.48 %, (Walkley and Black, 1934) available nitrogen 240.68 kg/ha (Subbiah and Asija, 1956) available phosphorus 16.83 kg/ha (Olsen et al., 1954) and available potash 299.0 kg/ha (Metson, 1956) as standardized. One month-old seedlings of cv. Pusa Narangi Gainda were transplanted at the spacing of 30 x 30 cm by drip irrigation in RBD factorial design. The observations on plant height, number of leaves/plant, days taken for first flower bud appearance, number of flowers per plant, carotene content (mg/g) and chlorophyll content (mg/g) were recorded (Wettstein, 1957, Sadasivam and Manickam, 1997 and Chaudhary et al., 2015).

Statistical analysis : The data generated from the present study were analyzed statistically and to draw suitable inference as per standard ANOVA technique described by Gomez and Gomez (1984).

RESULTS

The flowering and yield characters differed signifi-

cantly for the various zinc, salicylic acid levels and interactions of Zn x SA (Table 1&2).The maximum plant height (74.06 cm), number of leaves per plant (305.68), minimum days taken for first flower bud appearance (41.41 days), maximum number of flowers per plant (59.27), maximum (353.52 g), maximum carotene content (3.02 mg/g) and maximum chlorophyll content (3.61 mg/g) at Zn₄ (Zinc 1.0 %). while the minimum plant height (55.01 cm), number of leaves per plant (244.04), maximum days taken for first flower bud appearance (43.99 days), minimum number of flowers per plant (51.11) minimum carotene content (2.73 mg/g) and minimum chlorophyll content (2.87 mg/g) were recorded with Zn₀.

The maximum plant height (67.42 cm), number of leaves per plant (290.22), minimum days taken for first flower bud appearance (40.94 days), maximum number of flowers per plant (58.69), maximum carotene content (2.89 mg/g) and maximum chlorophyll content (3.44 mg/g) at SA₃ (Salicylic acid 0.50 mM/L). Similarly, the minimum days taken for first flower bud appearance (43.95 days), minimum number of flowers per plant (50.72), lowest chlorophyll content (3.06mg/

g) and minimum carotene content (2.76 mg/g) were recorded with SA₀.

The interaction of Zn & SA had the maximum plant height (77.41 cm), number of leaves per plant (314.10),earliest first flower bud appearance (39.78 days), maximum number of flowers per plant (62.33), maximum carotene content (3.07mg/g) and maximum chlorophyll content (3.87 mg/g) at Zn₄SA₃. While, the minimum plant height (50.12 cm), number of leaves per plant (189.78), longest first flower bud appearance (47.29 days), lowest chlorophyll content (2.57 mg/g) and minimum carotene content (2.63 mg/g) were recorded minimum number of flowers per plant (44.89) were recorded with control.

DISCUSSION

The increase in the growth characters with zinc and salicylic acid application might be attributed to synthesis of tryptophan which promotes intensity of auxins leading to more cell division and cell elongation, meristematic activity of the tissue and expansion of cells (Martin, 1966), enhanced the availability of macronu-

Table 1. Effect of Zinc and Salicylic acid on chemical constitute and growth of marigold.

Treatments	Carotene(mg/g)	Chlorophyll (mg/g)	Plant height (cm)	Number of leaves per plant
Zinc				
Zn ₀	2.73	2.87	55.01	244.04
Zn ₁	2.76	3.08	59.74	254.20
Zn ₂	2.80	3.33	64.96	265.92
Zn ₃	2.85	3.45	69.84	288.50
Zn ₄	3.02	3.61	74.06	305.68
CD at 5%	0.01	0.10	3.00	16.05
Salicylic acid				
SA ₀	2.76	3.06	60.93	241.97
SA ₁	2.82	3.26	64.45	270.05
SA ₂	2.86	3.31	66.09	283.55
SA ₃	2.89	3.44	67.42	290.22
CD at 5%	0.01	0.09	2.68	14.35
Interaction				
Zn ₀ SA ₀	2.63	2.57	50.12	189.78
Zn ₀ SA ₁	2.71	2.85	54.24	245.88
Zn ₀ SA ₂	2.77	2.97	56.62	269.69
Zn ₀ SA ₃	2.80	3.08	59.06	270.81
Zn ₁ SA ₀	2.70	2.90	56.77	208.92
Zn ₁ SA ₁	2.72	3.03	59.60	257.88
Zn ₁ SA ₂	2.79	3.11	60.84	270.81
Zn ₁ SA ₃	2.83	3.26	61.73	279.38
Zn ₂ SA ₀	2.73	3.15	61.28	242.81
Zn ₂ SA ₁	2.81	3.35	64.96	262.65
Zn ₂ SA ₂	2.83	3.36	66.23	276.04
Zn ₂ SA ₃	2.84	3.47	67.35	282.18
Zn ₃ SA ₀	2.79	3.23	68.21	268.89
Zn ₃ SA ₁	2.86	3.48	69.02	287.43
Zn ₃ SA ₂	2.89	3.50	70.55	293.08
Zn ₃ SA ₃	2.88	3.58	71.56	304.61
Zn ₄ SA ₀	2.97	3.43	68.22	299.46
Zn ₄ SA ₁	3.01	3.59	74.44	300.81
Zn ₄ SA ₂	3.03	3.63	76.18	308.33
Zn ₄ SA ₃	3.07	3.83	77.41	314.10
CD at 5%	0.03	0.21	NS	32.10

Table 2. Effect of zinc and salicylic acid on flowering parameter of marigold.

Treatments	First flower bud appearance (DAT)	Number of flowers per plant
Zinc		
Zn ₀	43.99	51.11
Zn ₁	42.94	53.48
Zn ₂	42.68	54.38
Zn ₃	41.70	56.98
Zn ₄	41.41	59.27
CD at 5%	0.91	2.05
Salicylic acid		
SA ₀	43.95	50.72
SA ₁	42.95	54.04
SA ₂	42.35	56.69
SA ₃	40.94	58.69
CD at 5%	0.82	1.83
Interaction		
Zn ₀ SA ₀	47.29	44.89
Zn ₀ SA ₁	43.72	50.60
Zn ₀ SA ₂	42.98	53.52
Zn ₀ SA ₃	41.99	55.42
Zn ₁ SA ₀	44.10	49.50
Zn ₁ SA ₁	43.41	52.46
Zn ₁ SA ₂	42.56	54.98
Zn ₁ SA ₃	41.70	56.98
Zn ₂ SA ₀	43.84	50.28
Zn ₂ SA ₁	43.33	53.45
Zn ₂ SA ₂	42.45	55.89
Zn ₂ SA ₃	41.10	57.89
Zn ₃ SA ₀	42.35	52.26
Zn ₃ SA ₁	42.24	55.96
Zn ₃ SA ₂	42.10	58.84
Zn ₃ SA ₃	40.14	60.84
Zn ₄ SA ₀	42.17	56.67
Zn ₄ SA ₁	42.05	57.75
Zn ₄ SA ₂	41.67	60.33
Zn ₄ SA ₃	39.78	62.33
CD at 5%	1.83	3.96

trients (Chattopadhyay, 1994; Keram *et al.*, 2014) and also increased number of internodes (Jaiwal and Bhambe, 1989). The salicylic acid could be attributed to its bio regulator effects on physiological and biochemical processes in plant and increased the number of nodes in plant (El-Tayeb, 2005). The present results are in conformity with the results of Pacheco *et al.* (2013) in marigold, Sharma *et al.* (2013) in gladiolus and Anwar *et al.* (2014) in tuberose. The increase in the flower characters with zinc and salicylic acid application might be attributed to more tryptophan production which acts as a precursor of auxin which increases the vegetative growth and leads to production of more food material, which in turn might have been utilized for better development of flowers (Muthumanickam, 1999). The salicylic acid might have altered the biophysical properties of cell wall and also there is a synergistic effect of salicylic acid and auxins (Padmapriya and Chezhiyan, 2002). The present results are in conformity with the results of Singh *et al.* (2012) in gladiolus, Pacheco *et al.* (2013) in marigold and An-

war *et al.* (2014) in tuberose. Days taken for first flower bud appearance may be due to zinc which acts as a co-factor of many enzymes and affects many biological processes thereby induces early flowering (El-Seifi and Esmael, 1997). While, the salicylic acid functioned as endogenous growth regulator of flowering as florigenic effects (Raskin *et al.*, 1992). The findings of this investigation are in line with of Pacheco *et al.* (2013) in marigold.

Maximum number of flower per plant might be due the application of zinc and salicylic acid which plays vital role for extended vegetative growth, pollen function, fertilization, metabolism of RNA, proteins and DNA formation (Pandey *et al.*, 2006). Similar results are also reported by Reddy and Rao (2012) in gerbera.

The application of zinc and salicylic acid provided maximum chlorophyll content due to stimulative effect of salicylic acid and zinc causing antioxidantal scavenging effect to protect chloroplasts (Bowler *et al.*, 1992). The increase in carotene content with salicylic acid and zinc might be attributed to the effect of these

substances on the biosynthesis of secondary metabolites and enhancing the photosynthetic activity in marigold (Kim *et al.*, 2009). Similar results were also reported by El-Naggar (2005) in gladiolus and Pacheco *et al.* (2013) in marigold.

It is evident that the foliar spraying with zinc 1.0% + salicylic acid 1.0 mM/L may positively regulated the marigold growth, flowering and chemical constitute thus improved the production.

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