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

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Abstract: A field experiment on African marigold (*Targets erecta* L.) was conducted during winter season of 2014-15to 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 treatmentZn_4SA_3 (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 increasedthe growth and flowering parametersof marigold.

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

INTRODUCTION

African marigold *(Tageteserecta*L.) belongs to family Asteracece is a very popular commercial flower crop as loose flower in Indiabecause of its wide adaptability to various soils, climatic conditions and easy cultivation. Marigold having ornamental, medicinal and industrialuses, 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 andchemical 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 to total flavonoids content of marigold plants.

Foliar applicationconstitute 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. PusaNarangiGainda 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 Zn_4 (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 Zn_0.

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 SA_3 (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 SA_0.

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 Zn_4SA_3. 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_0SA_0	2.63	2.57	50.12	189.78
Zn_0SA_1	2.71	2.85	54.24	245.88
Zn_0SA_2	2.77	2.97	56.62	269.69
Zn_0SA_3	2.80	3.08	59.06	270.81
Zn_1SA_0	2.70	2.90	56.77	208.92
Zn_1SA_1	2.72	3.03	59.60	257.88
Zn_1SA_2	2.79	3.11	60.84	270.81
Zn_1SA_3	2.83	3.26	61.73	279.38
Zn_2SA_0	2.73	3.15	61.28	242.81
Zn_2SA_1	2.81	3.35	64.96	262.65
Zn_2SA_2	2.83	3.36	66.23	276.04
Zn_2SA_3	2.84	3.47	67.35	282.18
Zn_3SA_0	2.79	3.23	68.21	268.89
Zn_3SA_1	2.86	3.48	69.02	287.43
Zn_3SA_2	2.89	3.50	70.55	293.08
Zn_3SA_3	2.88	3.58	71.56	304.61
Zn_4SA_0	2.97	3.43	68.22	299.46
Zn_4SA_1	3.01	3.59	74.44	300.81
Zn_4SA_2	3.03	3.63	76.18	308.33
Zn_4SA_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_0SA_0	47.29	44.89
Zn_0SA_1	43.72	50.60
Zn_0SA_2	42.98	53.52
Zn_0SA_3	41.99	55.42
Zn_1SA_0	44.10	49.50
Zn_1SA_1	43.41	52.46
Zn_1SA_2	42.56	54.98
Zn_1SA_3	41.70	56.98
Zn_2SA_0	43.84	50.28
Zn_2SA_1	43.33	53.45
Zn_2SA_2	42.45	55.89
Zn_2SA_3	41.10	57.89
Zn_3SA_0	42.35	52.26
Zn_3SA_1	42.24	55.96
Zn_3SA_2	42.10	58.84
Zn_3SA_3	40.14	60.84
Zn_4SA_0	42.17	56.67
Zn_4SA_1	42.05	57.75
Zn_4SA_2	41.67	60.33
Zn_4SA_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 Bhambie, 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 beattributed 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 Anwar *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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