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Foliar application of zinc and salicylic acid on African marigold

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ABSTRACT

A field experiment on African marigold (Targets erecta L.) was conducted during winter seasons in Jhalawar (Rajasthan.) 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^{-1}).The treatment Zn_4SA_3 (Zinc 1% + Salicylic acid 1.0 mM L^{-1}) recorded the maximum plant height, number of leaves per plant, main stem diameter, number of primary branches per plant, diameter of tap root, duration of flowering, first flower bud appearance, 50 per cent flowering, Duration of flowering (Days), maximum flower yield, carotene and chlorophyll. The results suggested that combined two foliar application of Zinc 1% + Salicylic acid 1.0 mM L^{-1} helps to achieve higher vegetative growth, flowering and chemical constitute of African marigold under Jhalawar conditions of Rajasthan.

Keywords : African marigold, pusa narangi gainda, salicylic acid, zinc

African marigold (*Tagete serecta* L.) is a widely cultivated as a loose flower garden plant for beautification and cut flower for local markets. It belongs to the family Asteraceae and having chromosome number 2n=24. It was introduced in India during 16th century and since then it has been naturalized in different agro climatic regions of India in such a way that it now appears to be native of this country. In Rajasthan, marigold is one of the most important flower crop. Marigold is a native of Central and South America especially Mexico. The generic name *Tagetes* is derived from, "*Tages*" the name of Estrucsch God, known for his beauty. French was the first to apply the name *Tagetes* which was later adopted by others (Kaplan, 1960). Marigold was domesticated and used as an ornamental plant during pre-Columbian period before they were introduced in Europe and South Asia including India. Marigold is used for stomach upset, ulcers, menstrual period problems, eye infections, inflammations, and for wound healing. It is antiseptic. If the Marigold flower is rubbed on the affected part, it brings relief in pain and swelling caused by a wasp or bee. A lotion made from the flowers is most useful for sprains and wounds and a water distilled from them is good the sore eyes. Marigold is major source of pigments in poultry feed and is commercially used for pigment deposition and for improving colour of poultry products (Hencken,1992). Zinc is essential micronutrient and also activator of enzymes like dehydrogenases, proteinases and peptidases.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). Salicylic acid (from Latin salix, willow tree, from the bark of which the substance used to be obtained) is a mono hydroxyl benzoic acid, a type of phenolic acid and a beta hydroxyl acid. It has the formula $C_7H_6O_3$. Salicylic acid (SA) is a phenolic compound, which plays an important role in regulation of plant growth and development, fruit yield, flowering and physiological processes and synthesis of auxins and cytokinins (Metwally*et al*.,2003). Exogenous application of Salicylic acid before reproductive stage may result in higher biomass production and 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 physiological and biological parameter 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 seasons. The soil had organic carbon 0.48 per cent, (Walkley and Black, 1934) available nitrogen 240.68 kg ha^{-1}, available phosphorus 16.83 kg ha^{-1} (Olsen *et al*., 1954). and available potash 299.0 kg ha^{-1}, (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

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on plant height, main stem diameter, number of primary branches plant^{-1}, number of leaves plant^{-1}, diameter of tap root, days taken for first flower bud appearance, days taken for 50% flowering, duration of flowering, flower yield ha^{-1}. carotene content and chlorophyll content were recorded (Choudhary *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).

Table1: Effect of zinc and salicylic acid on vegetative parameters of African marigold cv. *PNG*

Treatment	Plant height (cm)	Main stem diameter (cm)	Number of primary branches plant^{-1}	Number of leaves plant^{-1}	Diameter of tap root (cm)
Zinc					
Zn_0	55.01	1.22	7.96	244.04	1.11
Zn_1	59.74	1.27	8.84	254.20	1.14
Zn_2	64.96	1.30	9.89	265.92	1.17
Zn_3	69.84	1.35	10.36	288.50	1.22
Zn_4	74.06	1.41	10.93	305.68	1.31
LSD(0.05)	**3.00**	**0.05**	**0.46**	**16.05**	**0.03**
Salicylic acid					
SA_0	60.93	1.23	8.95	241.97	1.14
SA_1	64.45	1.29	9.58	270.05	1.17
SA_2	66.09	1.32	9.75	283.55	1.20
SA_3	67.42	1.39	9.95	290.22	1.25
LSD(0.05)	**2.68**	**0.05**	**0.39**	**14.35**	**0.03**
Interaction					
Zn_0SA_0	50.12	1.10	6.60	189.78	1.05
Zn_0SA_1	54.24	1.23	7.98	245.88	1.07
Zn_0SA_2	56.62	1.25	8.04	269.69	1.12
Zn_0SA_3	59.06	1.29	9.20	270.81	1.19
Zn_1SA_0	56.77	1.22	8.27	208.92	1.10
Zn_1SA_1	59.60	1.24	8.78	257.88	1.11
Zn_1SA_2	60.84	1.29	9.07	270.81	1.15
Zn_1SA_3	61.73	1.33	9.25	279.38	1.20
Zn_2SA_0	61.28	1.23	9.52	242.81	1.13
Zn_2SA_1	64.96	1.26	9.83	262.65	1.15
Zn_2SA_2	66.23	1.30	10.07	276.04	1.16
Zn_2SA_3	67.35	1.40	10.13	282.18	1.22
Zn_3SA_0	68.21	1.27	9.88	268.89	1.15
Zn_3SA_1	69.02	1.34	10.36	287.43	1.20
Zn_3SA_2	70.55	1.36	10.54	293.08	1.23
Zn_3SA_3	71.56	1.44	10.64	304.61	1.29
Zn_4SA_0	68.22	1.33	10.48	299.46	1.27
Zn_4SA_1	74.44	1.39	10.95	300.81	1.30
Zn_4SA_2	76.18	1.42	11.04	308.33	1.32
Zn_4SA_3	77.41	1.50	11.27	314.10	1.35
LSD(0.05)	**NS**	**NS**	**0.88**	**32.10**	**NS**

Vegetative parameters

The growth characters differed significantly for the various zinc, salicylic acid levels and interactions of Zn x SA (Table 1). The maximum plant height (77.41 cm), number of leaves per plant (314.10), main stem diameter (1.50 cm), number of primary branches plant^{-1} (11.27) and diameter of tap root (1.35 cm) were recorded with Zn_4SA_3 while, the minimum plant height (50.12 cm), number of leaves plant^{-1} (189.78), main stem diameter (1.10 cm), number of primary branches plant^{-1} (6.60) and diameter of tap root (1.05 cm) were recorded with control.

Zinc is one of the most important plant micro nutrients which helps synthesis of amino acid s, essential plant hormones, transporation of carbohydrates, regulates oxidation-reducation and photo-synthesis activity in the plants (Anuprita *et al.*, 2005; Shukla *et al*., 2009). Salicylic acid is recognized as a novel group of phytohormones to regulate the plant growth, stomatal closure, protein synthesis and transpiration at very low amounts El-Khallal *et al.*, 2009). Salicylic acid may increase the function of photosynthetic machinery in plants by mobilization of nitrate in internal tissue or chlorophyll biosynthesis. Salicylic acid with decreasing evapotranspiration and increasing root development can help root to absorb more nutrients (Shi *et al.* , 2006)

Table 2: Effect of zinc and salicylic acid on flowering parameters of African marigold cv. *PNG*

Treatments	First flower bud appearance (DAT)	Days taken for 50% flowering (DAT)	Duration of flowering (Days)	Flower yield ha^{-1}. (q)
Zinc				
Zn_0	43.99	66.70	53.67	181.25
Zn_1	42.94	63.37	55.26	209.05
Zn_2	42.68	63.54	56.51	220.58
Zn_3	41.70	63.23	58.72	236.40
Zn_4	41.41	61.85	59.85	242.69
LSD(0.05)	**0.91**	**0.76**	**1.45**	**14.40**
Salicylic acid				
SA_0	43.95	64.70	55.49	189.43
SA_1	42.95	64.32	56.46	207.44
SA_2	42.35	63.27	56.95	236.20
SA_3	40.94	61.46	58.31	238.90
LSD(0.05)	**0.82**	**0.68**	**1.30**	**12.88**
Interaction				
Zn_0SA_0	47.29	71.01	51.68	131.35
Zn_0SA_1	43.72	67.66	53.88	174.82
Zn_0SA_2	42.98	66.08	54.33	211.75
Zn_0SA_3	41.99	62.06	54.78	207.08
Zn_1SA_0	44.10	64.67	54.45	177.82
Zn_1SA_1	43.41	64.47	55.12	191.32
Zn_1SA_2	42.56	62.60	55.34	233.38
Zn_1SA_3	41.70	61.78	56.14	233.65
Zn_2SA_0	43.84	64.67	55.08	191.68
Zn_2SA_1	43.33	64.40	55.98	213.66
Zn_2SA_2	42.45	62.90	56.98	238.40
Zn_2SA_3	41.10	61.76	57.98	238.58
Zn_3SA_0	42.35	63.47	57.46	214.30
Zn_3SA_1	42.24	63.08	57.96	222.57
Zn_3SA_2	42.10	62.60	58.67	253.41
Zn_3SA_3	40.14	61.15	60.78	255.33
Zn_4SA_0	42.17	62.98	58.78	231.99
Zn_4SA_1	42.05	61.41	59.35	234.82
Zn_4SA_2	41.67	60.95	59.43	244.07
Zn_4SA_3	39.78	59.73	61.85	259.87
LSD(0.05)	**1.83**	**1.53**	**2.90**	**28.80**

Floral parameters

The flower characters differed significantly for the various zinc, salicylic acid levels and interactions of Zn x SA (Table 2). The interaction effects of zinc and salicylic acid levels showed significant differences on flowering characters. The earliest first flower bud appearance (39.78 days), 50 per cent flowering (59.73 days), longest duration of flowering (61.85 days) and maximum flower yield ha^{-1} (259.87 q)) were recorded with $Zn_4SA_3$and latest flower bud appearance (47.29 days), 50 per cent flowering (71.01 days), shortest duration of flowering (51.68 days) and flower yield ha^{-1} (145.94 q) were recorded with control. Significant differences were also noted with application of different levels of zinc, salicylic acid and their interaction.

Table 3: Effect of zinc and salicylic on chemical constitute of African marigold cv. *PNG*

Treatments	Carotene (mg g^{-1})	Chlorophyll (mg g^{-1})
Zinc		
Zn_0	2.73	2.87
Zn_1	2.76	3.08
Zn_2	2.80	3.33
Zn_3	2.85	3.45
Zn_4	3.02	3.61
LSD(0.05)	**0.01**	**0.10**
Salicylic acid		
SA_0	2.76	3.06
SA_1	2.82	3.26
SA_2	2.86	3.31
SA_3	2.89	3.44
LSD(0.05)	**0.01**	**0.09**
Interaction		
Zn_0SA_0	2.63	2.57
Zn_0SA_1	2.71	2.85
Zn_0SA_2	2.77	2.97
Zn_0SA_3	2.80	3.08
Zn_1SA_0	2.70	2.90
Zn_1SA_1	2.72	3.03
Zn_1SA_2	2.79	3.11
Zn_1SA_3	2.83	3.26
Zn_2SA_0	2.73	3.15
Zn_2SA_1	2.81	3.35
Zn_2SA_2	2.83	3.36
Zn_2SA_3	2.84	3.47
Zn_3SA_0	2.79	3.23
Zn_3SA_1	2.86	3.48
Zn_3SA_2	2.89	3.50
Zn_3SA_3	2.88	3.58
Zn_4SA_0	2.97	3.43
Zn_4SA_1	3.01	3.59
Zn_4SA_2	3.03	3.63
Zn_4SA_3	3.07	3.83
LSD(0.05)	**0.03**	**0.21**

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 there by induces early flowering and promoted reproductive phase resulting While, the salicylic acid functioned as endogenous growth regulator of flowering as florigenic effects (Raskin *et al*.,1992). Maximum duration of flowering might be due the application of salicylic acid and zinc is effective on a wide range of physiological processes and showed synergetic effect with auxin and gibberellins. The highest flower yield per hectare might be due to accommodation of maximum number of flower per hectare along with higher enlarged vegetative growth, photosynthetic pigments, minerals and some bio constituents which affect plant growth and in turn increased yield (Gharib, 2006).The present results are in conformity with the results of Reddy and Rao (2012) and Yadegari and Shakerian (2014) .

Chemical constitute

The interaction of Zn and SA had the maximum carotene content (3.07mg g^{-1}) and maximum chlorophyll content (3.87 mg g^{-1}) at Zn_4SA_3 and lowest chlorophyll content (2.57 mg g^{-1}) and minimum carotene content (2.63 mg g^{-1}) with control.

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 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.

It is postulated that the foliar spraying with zinc 1.0% + salicylic acid 1.0 mM L^{-1} may positively regulated the marigold growth, chemical constitute and thus improved the production.

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