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EFFECT OF FOLIAR APPLICATION OF NAA AND MICROELEMENTS ON VIGOUR AND FLOWERING OF MARIGOLD (*Tagetes erecta* L.) CV. PUSA BASANTI

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ABSTRACT : Results of the field experiment revealed that vigour of marigold plant was significantly increased due to foliar application of NAA and microelements. The production and size of floral heads were also improved significantly by the NAA and microelement treatments. The spray of 100 ppm NAA at 15 days after transplanting and 0.50% $ZnSO_4$ at 30 days after transplanting proved significantly effective for yield and floriferousness of marigold cv Pusa Basanti. Minimum plant height was observed in control while the maximum height was recorded by NAA100ppm.Values were in between with the borax treatment. Parameters *viz.,* diameter of main stem, spread of plant along the row, spread of plant across the row, number of primary branches/plant, length of the longest primary branch, number of secondary branches on the highest primary branch, number of leaves on highest primary branch and fresh weight of plant canopy were found to be influenced significantly with treatments and followed same pattern as in case of plant height. It seems that auxins have great potential to determine plant orientation, flower bud differentiation and economic production.

Keywords : *Marigold, vigour, NAA, micronutrients, $ZnSO_4$, yield, borax.*

Marigold (*Tagetes erecta* L.) belongs to family Asteraceae and grown as a ornamental crop for loose flowers, as a landscape plant and as a source of pigment for poultry feed (Ullah *et al.* 11). Now a days it is commonly used for garland making in India because of ease in cultivation and adaptability to varying soil and climatic conditions, long duration of flowering and attractively coloured flower heads of excellent keeping quality. It is an economic produce as compared to other costly flowers. Both leaves and flowers are equally important from the medicinal point of view. Leaf paste is used externally against boils and carbuncles. Control and reorientation of flowering is one of the most important practical aspects in application of plant growth regulators (Ullah *et al.* 11). There are many examples of utilization of growth regulators to regulate the flowering in ornamental and medicinal and aromatic plants (Kumar *et al. 8;* Shukla and Farooqi, 10). Increasing interest has been observed in the use of PGRs like NAA in vigour promotion of plant. However, information on the effect of NAA and microelements like zinc and borax on ornamental crops is rather meager. The significance of microelements in manurial schedule of horticultural crops has been recognized only in the recent years. Micronutrients are essential for balanced nutrition. Their deficiency caused several disorders which ultimately reduced yield and quality of the plants. They complete the life cycle of the plant seed to seed successfully. They improve colour of the flower. Vase life of flower after harvest was also found to increase with micronutrient application. Zinc and boron elements performed several functions as zinc increases gibberellic like growth promoters activity hence its deficiency caused dwarfism and little leaf disorder. Boron helps in sugar mobilization. Petal unfurling is depending on boron availability. Therefore, an experiment was conducted to study the influence of foliar application of NAA, zinc and borax on vigour and flowering behavior of marigold c.v. Pusa Basanti .

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MATERIALS AND METHODS

The field experiment was conducted during the winters in 2010-11 at the Department of Horticulture, Kulbhaskar Ashram Post Graduate College, Allahabad, Uttar Pradesh. The soil of experimental plot was sandy loam with good moisture-holding capacity and the pH was near neutral *i.e.,* 7.7. Field situation was open and optimum drainage facility was provided. Clean cultivation was followed. The treatments of foliar application 0.0 ppm (N_0) 50 ppm (N_1) and 100 ppm (N_2) concentrations of NAA along with 0.0%, (Z_0) 0.25% (Z_1) and 0.50% (Z_2) zinc sulphate (Z_2) and 0.15% (B_1) and 0.30% (B_2) borax forming fifteen treatment combinations, were tested in the Randomized Block Design with four replications. The seedlings of 30 days old were transplanted on November 10, 2010 at 45 cm x 45 cm spacing. FYM as a basal dose was applied to all the plots uniformly @ 3.5 kg per m^2 before transplanting. Besides, 8g each of

P_2O_5 and K_2O through Di-ammonium Phosphate and Muriate of Potash, respectively were also applied at the time of last ploughing. The crop was top-dressed only once with 8 g per m^2 of nitrogen through urea at 45 days after transplanting. Treatments were applied in three split doses *i.e.,* 25, 50 and 75 days after transplanting. Spraying was done in such a way that entire plant was drench profusely in all direction. Spraying was done in mid day just to allow to escape dew completely. Except treatments all other cultural practices were followed as per recommendation.

The parameters of vigour and flowering (Table 1 & 2) were recorded at the full blooming stage in the first week of March.

RESULTS AND DISCUSSION

Effect of NAA on plant vigour

A significant change in the vigour parameters was recorded due to NAA spray (Table 1). The fresh weight of biomass increased profusely due to application of 100 ppm NAA. Simultaneously, increase in the plant height, diameter of main-stem, spread of plant along and across the row, number of primary branches and number of leaves on the longest primary branch was also observed and followed similar pattern as fresh weight of plant. The application of 50 ppm NAA was also found significantly effective over control in improving plant vigour but 100 ppm NAA was significantly more effective than its 50 ppm doze. These results are in close conformity with those of Chairani (3) and Kumar *et al.* (8).

Metabolites partition and chanalization helped in apical dominance which ultimately improved the length of the longest primary branch as application of NAA might be increased the plant vigour which promotes rooting and improves efficiency of nutrient uptake. Overall increase in biomass may be attributed to the fact that NAA increases CO_2 fixation, chlorophyll content of leaves and photosynthate assimilation.

Reproductive phase (Table 2) was significantly influenced by NAA application. There was significant increase in the number and weight of flower heads per plant due to NAA spray. The increase in fresh weight of floral heads with the spray of NAA over control might be due to mobilization or movement of nutrients in to flowers. This also explains that NAA helps in sink-source ratio maintenance. Similar effect of NAA has been reported by Subramanian and Janardhan (9), Waseem *et al.* (12) and Hooda *et al.* (7). The size of the floral head was also improved significantly over control by the application of NAA. Such changes in the size of floral head and their number per plant were due to NAA application which may be attributed to mobilization of hormones and metabolites. The duration required for

Table 1 : Effect of foliar application of NAA and micro-elements on vigour parameters of marigold cv. Pusa Basanti.

S. No.	Treatments	NAA (ppm)			CD (P= 0.05)	Micro-elements (%)					CD (P = 0.05)
		0.00 (N_0)	50 (N_1)	100 (N_2)		0.0% $ZnSO_4$ (Z_0)	0.25% $ZnSO_4$ (Z_1)	0.50% $ZnSO_4$ (Z_1)	0.15% Borax (B_1)	0.30% Borax	
1.	Plant height (cm)	57.32	59.18	61.12	0.84	57.96	58.84	59.36	59.27	59.27	1.11
2.	Diameter of main stem (cm)	1.38	1.53	1.59	0.05	1.42	1.46	1.53	1.54	1.54	0.06
3.	Spread of plant along the row (cm)	37.18	39.04	39.04	0.59	37.61	38.51	39.03	39.16	39.16	0.79
4.	Spread of plant across the row (cm)	36.78	39.07	39.07	0.82	37.51	33.51	38.83	39.23	39.67	1.09
5.	Number of primary braches on the plant	10.78	12.07	13.20	0.19	11.52	11.72	12.00	12.40	12.78	0.27
6.	Length of the longest primary branch (cm)	34.69	38.00	40.85	0.50	35.98	36.85	38.48	38.65	39.16	0.68
7.	Number of secondary branches on the highest primary branch	4.92	5.54	6.07	0.20	5.07	5.38	5.55	5.75	5.80	0.29
8.	Number of leaves on highest primary branch	35.52	43.22	47.59	0.64	39.77	40.75	32.38	44.27	44.38	0.85
9.	Fresh weight of plant canopy (g)	279.50	315.15	358.45	7.96	301.17	307.17	317.50	32.50	338.42	10.57

full blooming since transplanting was increased by the application of NAA. This is because of ability of NAA to increase duration of vegetative phase. The duration required for full blooming since transplanting was 98.07 days with 100 ppm NAA application which decreased to 94.40 and 91.30 days when the plants were sprayed with 50 ppm and 0.00 ppm of NAA, respectively. This justifies that NAA helps in increasing juvenile phase of plant.

Effect of microelements on vigour and flowering

Foliar application of zinc sulphate particularly at 0.50% concentration caused positive modifications in the vigour parameters such as increased plant height, diameter of main-stem, spread of plant along and across the row, number of primary branches per plant, length of the longest primary branch, number of secondary branches on the longest primary branch and number of leaves on the longest primary branch, mainly due to participation of zinc in the metabolism of plant as an activator of several enzymes such a *carbonic anhydrase, alcohol dehydrogenase* and pyridine nucleotide dehydrogenase. Zinc stimulates the production of IAA hormone which helps in increasing vegetative growth of the plant. Similar effect of $ZnSO_4$ on crop plants have been reported by Deka and Arjuna (5), Farooqi *et al.* (6) and Barman and Pal (2). The effect of $ZnSO_4$ treatments was significant on the fresh weight of plant canopy as evinced by the application of 0.50% spray of $ZnSO_4$ which produced the maximum fresh weight of biomass (317.50 g) being significantly more over other treatments (Z_0 and Z_1). Likewise, there were considerable manifestations in the vigour characters due to borax spray. Borax has been capable of acting as electron carrier in enzyme system which brings about rapid oxidation-reduction in plants. The foliar application of Borax increased the plant height over B_0 (control). The borax treatment significantly increased the diameter of main-stem and simultaneously also spread of plant along and across the row. Under B_0 the values of these parameters were 37.61 cm and 37.51 cm in comparison to 39.16 cm and 39.67 cm, respectively with the application of 0.30% Borax. These results clearly proved the vigour-promoting effect of spray of 0.30% borax (Table 1 and 2) . The number of primary branches and length of the longest primary branch also increased significantly by the foliar application of borax (0.30%). As a result, the fresh weight of plant canopy increased significantly over control by the foliar application of Borax. The duration required for full blooming was reduced significantly by the application of 0.30% borax. A similar impact of borax was also noted on the size of the largest floral head. The number of floral heads per plant under the influence of 0.30% borax (B_2) also revealed significant increase over control. Thus, foliar application of borax brought about prolific flowering which coincided with the results reported by Cantrill (4) and Bandopadhyay *et al.* (1).

Effect of NAA, zinc sulphate and borax on shelf life of marigold flower was conspicuous. All the treatments yielded significant better results over control. In situ shelf life that is at field level was maximum with 0.50% zinc sulphate followed by borax and NAA, respectively. Flowers were assumed fresh and marketable till petals remain furled, turgid, stiff and spotless. Slightly deviation from these traits flowers were considered

Table 1 : Effect of foliar application of NAA and micro-elements on flowering behaviour and shelf life of marigold cv. Pusa Basanti.

S. No.	Treatments	NAA (ppm)			CD (P= 0.05)	Micro-elements (%)					CD (P = 0.05)
		0.00 (N_0)	50 (N_1)	100 (N_2)		0.0% $ZnSO_4$ (Z_0)	0.25% $ZnSO_4$ (Z_1)	0.50% $ZnSO_4$ (Z_1)	0.15% Borax (B_1)	0.30% Borax	
1.	Duration required full blooming (Days)	98.07	94.40	91.30	0.38	96.14	95.61	94.44	93.06	93.69	0.42
2.	Size of the largest floral head (cm)	7.92	8.20	8.33	0.07	8.01	8.07	8.19	8.25	8.22	0.09
3.	Number of flower heads per plant	16.91	19.05	20.76	1.04	17.90	18.10	18.45	20.58	19.50	1.25
4.	Fresh weight of floral head per plant (g)	44.25	47.90	54.10	160	46.33	47.42	49.08	50.75	50.17	2.10
5.	*In-situ* shelf life at ambient temperature (days)	11.25	16.66	26.54	1.09	11.35	17.29	27.33	16.89	27.01	1.10
6.	*Ex-situ* shelf life at room temperature (days)	5.61	8.31	13.10	0.08	5.70	8.44	13.94	8.43	13.20	0.88

unfit for the purpose. *Ex-situ* shelf life was recorded by putting stalked flowers (cut flowers) in vase containing solution of water and 0.25 % sugar. Flowers remain in better condition in treatments as compared to control and showed similar pattern as that in *in-situ* shelf life of flowers.

Conclusion

It may be concluded that cultivar Pusa Basanti of marigold had responded well to NAA, zinc sulphate and borax to growth, flower yield and shelf life of flowers over control. Best quality of flower was found in NAA 100 ppm which is entirely marketing character and helps in fetching remunerative price. Productivity was also maximum with same treatment therefore in yield point of view may be considered. High shelf at field level helps farmer to sell their produce over longer period. This will help farmers not to selling their produce forcefully as a matter of perishability. Though the shelf life was best in zinc sulphate but NAA 100 ppm also responded better in this respect. Precisely, therefore farmers are advocated to apply NAA 100 ppm in marigold crop for yield, quality and shelf life for commercial cultivation.

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