THE ASIAN JOURNAL OF HORTICULTURE
Volume **8** | Issue 2 | December, 2013 | 466-469

Research Paper

Article history **:**
Received : 30.04.2013
Revised : 05.09.2013
Accepted : 20.09.2013

Effect of integrated system of plant nutrition management on growth, yield and flower quality of African marigold (*Tagetes erecta* L.) cv. PUSA NARANGI

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ABSTRACT : A field experiment was conducted on the ffect of integrated nutrient management on African marigold (*Tagetes erecta* L.) cv. PUSA NARANGI was conducted at Lal baug farm, Department of Horticulture, Junagadh Agricultural University, Junagadh during winter season of two consecutive years *i.e.* 2011 and 2012. In which 70% RDF + 2 t ha^{-1} vermicompost + *Azotobacter* + *Azospirillium* + PSB significantly improved growth parameters *viz*., plant height at full bloom stage (115.45 cm), number of primary branches per plant at full bloom stage (28.06). 60% RDF + 3 t ha^{-1} vermicompost + *Azotobacter* + *Azospirillium* + PSB significantly improved flowering parameters *viz*., the shortest number of days taken to first flower open (53.72 days) and number of picking (9.12) and the shortest number of days taken for 50% flowering (59.50 days). The maximum diameter of flower (7.30 cm) recorded with treatment 70% RDF + 2 t ha^{-1} vermicompost + *Azotobacter* + *Azospirillium* + PSB. The longest duration of flowering (61.14 days), was recorded in 70% RDF + 2 t ha^{-1} vermicompost + *Azospirillium* + PSB. The treatment 70% RDF + 2 t ha^{-1} vermicompost + *Azotobacter* + *Azospirillium* + PSB significantly gave higher yield parameters *viz*., flower yield per plant (376.57) and flower yield per hectare (185.65 qha^{-1}). Quality parameters *viz*., shelf life of flower was significantly highest (4.95 days) in treatment 200kg N/ha + 100kg P_2O_5/ha + 100kg K_2O/ha + 15 t ha^{-1} FYM (RDF).

KEY WORDS : Marigold, Bio fertilizer, Growth, Quality, Yield

HOW TO CITE THIS ARTICLE : Thumar, B.V., Barad, A.V., Neelima, P. and Bhosale, Nilima (2013). Effect of integrated system of plant nutrition management on growth, yield and flower quality of African marigold (*Tagetes erecta* L.) cv. PUSA NARANGI. *Asian J. Hort.*, **8**(2) : 466-469.

Marigold is one of the most important commercial flower crops grown all over the world and in India as well; accounting for more than half of Nation's loose flower production (Sreekanth *et al.*,2006). It occupies importance amongst gardeners and flower-dealers on account of its easy cultivation, wide adaptability to soil and climatic conditions, free flowering habit, short duration required for producing marketable flowers, wide spectrum of attractive colours, shape, size and good keeping quality.

Although excessive use of inorganic fertilizers to achieve highest yield resulted numerous problems like micronutrient deficiencies, nutrient imbalance, deterioration of soil health and deteriorate crop yield. No single source of nutrient is capable of supplying plant nutrients in adequate amount and in balance proportion. Thus, integrated nutrient management is a strategy for advocating judicious and efficient use of chemical fertilizers with matching addition of organic manures and bio fertilizers. Such integrated nutrient management practices reduce the amount of inorganic fertilizers, control soil pollution in part at least caused due to use of high doses of fertilizers and protection of natural resources.

RESEARCH METHODS

The experiment was carried out during winter season of the year 2010-11 and 2011-12, at Lalbaug farm, Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh. The experiment was laid

out in a Randomized Block Design with three replications and eleven treatments were tried, comprising (T_1) 200kg N ha^{-1} + 100kg P_2O_5 ha^{-1} + 100kg K_2O ha^{-1} (control), (T_2) 200kg N ha^{-1} + 100kg P_2O_5 ha^{-1}+100kg K_2O ha^{-1}+15 t ha^{-1} FYM (RDF), (T_3) 70% RDF + 2 t ha^{-1} vermicompost +*Azotobacter* + PSB, (T_4) 70% RDF+2 t ha^{-1} vermicompost + *Azospirillium* + PSB, (T_5) 70% RDF + 2 t ha^{-1} vermicompost + *Azotobacter* +*Azospirillium*+PSB, (T_6) 60% RDF + 3 t ha^{-1} vermicompost +*Azotobacter*+PSB, (T_7) 60% RDF + 3 t ha^{-1} vermicompost +*Azospirillium*+PSB, (T_8) 60% RDF + 3 t ha^{-1} vermicompost +*Azotobacter*+*Azospirillium* + PSB, (T_9) 50% RDF+4 t ha^{-1} vermicompost + *Azotobacter* + PSB, (T_{10}) 50% RDF + 4 t ha^{-1} vermicompost+*Azospirillium*+PSB and (T_{11}) 50% RDF+4 t ha^{-1} vermicompost+*Azotobacter*+*Azospirillium* +PSB. Both vegetative and flower characters were recorded from five plants which were randomly selected and labelled in each plot.

Vegetative characters *viz.,* plant height and number of branches were recorded. Flower characters *viz.,* number of days taken to first flower open, days to 50% flowering, number of pickings, number of flowers per plant, flower yield per plant and per hectare, duration of flowering (days), diameter of flower(cm) and shelf life (days) of the flower were recorded.

RESEARCH FINDINGS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarised under following heads:

Growth characters:

Plants receiving 70% RDF + 2 t ha^{-1} vermicompost + *Azotobacter*+*Azospirillium*+PSB(T_5) recorded significantly higher plant height (during both the years and in the pooled results, respectively) followed by T_8 and T_{11}. The increase in the plant height in the treatments T_5, T_8 and T_{11} might be due to the beneficial effect of vermicompost, and bio fertilizers in combination with reduced recommended dose of inorganic fertilizers (70% RDF). Similar findings were reported by Ajitkumar (2002) with respect to application of vermicompost and inorganic fertilizers (RDF) in marigold. Similarly higher number of primary branches per plant was recorded under treatment T_5 at full bloom stage followed by T_8, T_{11} and T_2. This could be attributed to better flow of various micro and macro nutrients along plant growth substances into the plant system in the plots applied with vermicompost and bio fertilizers in combination with inorganic fertilizers. The growth regulators like NAA and cytokinins released by *Azospirillum* and PSB might have resulted in breaking of apical dominance and accelerated higher number of branches. The increased nitrogen nutrition may also have accelerated the process of cell division and differentiation. Similar findings were also reported by Rathi *et al.* (2005) and Sunitha *et al.* (2007) in marigold.

Flowering characters :

Initiation of first flower was noted earlier under the treatment T_8 it was remained at par with treatments T_5, T_{11}, T_3 and T_4. Minimum days to 50% flowering were noticed with the treatment T_5 which was at par with treatment T_8. This might be due to the altered C: N ratio which helped in balanced management of vegetative and reproductive phases and promote early flowering. The earliness of flowering may be attributed to the presence of bio fertilizers especially

Table 1: Plant height and primary branches in marigold cv. PUSA NARANGI as influenced by INM

Treatments	Plant height (cm)			Primary branches		
	2011	2012	Pooled	2011	2012	Pooled
T_1	97.10	95.30	96.20	18.17	19.27	18.72
T_2	105.30	104.53	104.92	23.73	23.03	23.38
T_3	104.20	98.30	101.25	22.77	21.77	22.27
T_4	97.10	101.10	99.10	22.47	21.58	22.03
T_5	116.70	114.20	115.45	27.61	28.51	28.06
T_6	99.60	99.50	99.55	21.60	23.71	22.66
T_7	106.50	104.50	105.50	22.77	24.11	23.44
T_8	110.40	112.20	111.30	26.70	26.00	26.35
T_9	90.00	88.00	89.00	17.00	16.67	16.84
T_{10}	96.30	98.70	97.50	18.71	19.61	19.16
T_{11}	104.40	100.20	102.30	24.72	25.44	25.08
S.E. $\pm$	4.6	4.3	3.1	1.3	1.2	0.9
C.D. (P=0.05)	13.44	12.77	8.98	3.91	3.69	2.60
CV%	8.10	7.75	7.93	10.57	9.82	10.19
Inte. Y×T	NS	NS	NS	NS	NS	NS

NS=Non-significant

inoculation with *Azospirillium* and PSB, which consequently lead to flower initiation and more flower duration.

The results of the present study are in conformity with those of Kapadiya (2007) and Naik (2008) in marigold. A perusal of the data revealed that treatments T_8 (60% RDF + 3 t ha^{-1} vermicompost + *Azotobacter* + *Azospirillium* + PSB) followed by T_{11} and T_5 recorded significantly maximum number of pickings. This increase was attributed to the constant and optimal supply of nutrients influenced better growth in terms of number of branches, increased number of flowers which in general have significant positive correlation with number of pickings. The results of the present study are in conformity with those of Kapadiya *et al*. (2007) and Naik *et al.* (2008) in marigold, Chaitra and Patil (2007) and Patil *et al*. (2008) in China aster. Significantly increase in number of flowers per plant, flower yield per plant (g), and flower yield per hectare (q) was observed with treatment T_5 as compared to rest of the treatments. This might be due to the fact that biofertilizers produce the growth promoting substances such as IAA, gibberellins like substances, vitamin B_{12}, thiamine, riboflavin (B_2), etc. which might have enhanced the soil fertility when

Table 2: Flowering attributes in marigold cv. PUSA NARANGI as influenced by INM

Treatments	Days to open first flower			Days to 50% flowering			No. of. pickings			Flowering duration		
	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled
T_1	67.34	67.80	67.58	6.47	6.34	6.40	75.16	73.67	74.41	45.20	44.17	44.69
T_2	65.08	65.40	65.24	8.23	8.13	8.18	74.94	72.73	73.83	48.70	47.67	48.19
T_3	60.19	61.53	60.90	8.33	8.18	8.26	69.78	68.55	69.16	53.90	51.87	52.88
T_4	61.24	61.02	61.13	6.94	7.04	6.99	67.67	64.33	66.00	62.10	60.17	61.14
T_5	55.73	54.94	55.34	8.67	8.49	8.58	60.00	59.00	59.50	59.30	58.27	58.79
T_6	63.33	62.64	62.99	8.00	8.10	8.05	65.16	63.92	64.54	54.03	52.07	53.05
T_7	63.66	62.98	63.32	8.33	8.17	8.25	67.33	65.67	66.50	54.10	52.27	53.19
T_8	53.67	53.76	53.72	9.20	9.05	9.12	61.33	60.00	60.67	57.60	55.97	56.79
T_9	68.13	68.33	68.23	6.10	6.19	6.15	76.00	75.00	75.50	46.40	45.37	45.89
T_{10}	72.82	71.62	72.22	6.33	6.47	6.40	75.82	73.00	74.41	43.10	42.07	42.59
T_{11}	60.11	61.50	60.80	9.00	8.91	8.96	64.67	63.33	64.00	56.80	55.01	55.91
S.E. ±	2.56	2.01	1.63	1.98	1.98	1.40	6.47	6.34	6.40	2.58	2.61	1.84
C.D. (P=0.05)	7.56	5.93	4.65	8.23	8.13	8.18	5.84	5.84	4.00	7.62	7.69	5.25
CV%	7.11	5.59	6.40	8.33	8.18	8.26	4.97	5.08	5.03	8.55	8.88	8.72
Inte. Y×T	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS=Non-significant

Table 3: Flower yield in marigold cv. PUSA NARANGI as influenced by INM

Treatments	Flower yield					
	Plant (g)			hectare (q)		
	2011	2012	Pooled	2011	2012	Pooled
T_1	214.92	201.62	208.20	105.96	99.40	102.65
T_2	273.14	262.19	267.62	134.66	129.26	131.95
T_3	287.18	277.73	282.40	141.58	136.92	139.24
T_4	310.44	294.06	302.22	153.05	144.97	148.98
T_5	379.61	373.02	376.50	187.15	183.90	185.65
T_6	295.74	286.99	291.30	145.80	141.48	143.63
T_7	311.06	295.15	303.32	153.35	145.51	149.53
T_8	358.25	337.69	347.90	176.62	166.48	171.51
T_9	188.05	181.97	185.00	92.71	89.71	91.21
T_{10}	211.90	196.49	204.1	104.47	96.87	100.63
T_{11}	329.88	333.12	331.5	160.17	161.76	160.98
S.E. ±	21.06	24.09	16.00	10.40	11.46	7.74
C.D. (P=0.05)	62.14	71.07	45.73	30.69	33.82	25.12
CV%	13.14	15.64	14.40	13.16	15.12	14.14
Inte. Y×T	NS	NS	NS	NS	NS	NS

NS=Non-significant

Table 4: Diameter and shelf life of marigold cv. Pusa Narangi as influenced by INM

Treatments	Diameter (cm)			shelf life (days)		
	2011	2012	Pooled	2011	2012	Pooled
T_1	5.33	5.10	5.22	3.20	3.20	3.20
T_2	5.67	5.33	5.50	5.00	4.90	4.95
T_3	6.33	6.53	6.43	3.87	3.83	3.85
T_4	5.84	6.07	5.96	3.92	3.88	3.90
T_5	7.10	7.50	7.30	4.40	4.40	4.40
T_6	6.20	6.33	6.27	3.65	3.55	3.55
T_7	6.25	6.45	6.35	3.99	3.88	3.94
T_8	6.98	6.86	6.92	4.00	4.00	4.00
T_9	5.03	5.10	5.07	3.37	3.23	3.30
T_{10}	5.27	5.07	5.17	3.03	2.90	2.97
T_{11}	6.67	6.89	6.78	4.65	4.54	4.60
S.E. $\pm$	0.26	0.31	0.20	0.28	0.27	0.19
C.D. (P=0.05)	0.76	0.92	0.58	0.82	0.78	0.55
CV%	7.41	8.87	8.18	12.35	12.06	12.21
Inte. Y×T	NS	NS	NS	NS	NS	NS

NS=Non-significant

vermicompost was applied with balanced dose of inorganic fertilizers increased the availability of essential plant nutrients which might enhanced root and shoot development and thereby growth. Thereafter, it might have influenced the reproductive phase and induced flowering which resulted in increased number of flowers per plant, flower yield per plant and per hectare. These findings are in accordance with those of Sunitha *et al.* (2007). A close perusal of data on duration of flowering (Table 2) indicated that an application of 70 per cent RDF + 2 t ha^{-1} vermicompost + *Azospirillium* + PSB (T_4) registered significantly longest (61.14 days) duration of flowering, but found statistically at par with treatments T_5 (58.79), T_8 (56.79) and T_{11} (55.91). Treatment T_5 recorded maximum flower diameter, which was at par with treatments T_8 and T_{11}. Significantly increased shelf life was recorded in the treatment T_2. While shelf life of flowers exhibited decreasing trend with increasing the levels of nitrogen. This may be due to the reason that higher dose of nitrogen keeps the flower tender and succulent in texture and this type of texture of flower resulted in higher and faster respiration and dehydration (Anuradha *et al.*, 1990). Similar results were also obtained by Suthar (2005) in marigold.

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