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Effect of source of nitrogen and vermi compost on growth, flowering attributes and yield of African marigold (*Tagetes erecta* L.)

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Abstract
The investigation entitled "Effect of nitrogen and vermi compost application on growth, flower yield, and shelf life of flower in marigold (*Tagetes erecta* L.) cv. Double Orange" was carried out at Jambuvadi Farm, Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh, during December 2016 to May 2017. The experiment was laid out in Randomized Block Design with Factorial concept (FRBD) consisting two factors with three replications. The treatment comprised with four levels of Nitrogen *viz*., 0kg ha^{-1}, 150kg ha^{-1}, 200kg ha^{-1}, 250kg ha^{-1} and four levels of vermi compost 0 tonne ha^{-1}, 2 tonne ha^{-1}, 4 tonne ha^{-1} and 6 tonne ha^{-1}.The results of the study indicated that application of nitrogen @250kg ha^{-1} significantly improved the plant height at 30 DAP (34.72cm), 60 DAP (55.07cm) and 90 DAP (85.39cm), increase number of primary branches (11.34) and secondary branches (33.78), stem diameter (2.03cm), fresh weight of the plant (371.60 g) and dry weight of the plant (68.03 g). While, minimum days to opening first flower (50.18 days), days to 50% flowering (62.98 days) shelf life of flower (4.03 days) and vase life of flower (6.80 days) were obtained in the treatment of 0kg ha^{-1} nitrogen (Control). Whereas, application of nitrogen @200kg ha^{-1} recorded highest flowering span (49.33days), number of flowers per plant (41.29), weight of single flower (6.03 g), weight of flowers per plant (251.98 g), flowers yield per plot (6.30kg), flowers yield per hectare (18.66 t/ha). In also of vermi compost the variation was also found significant. The maximum plant height at 30 DAP (34.53cm), 60 DAP (55.11cm) and 90 DAP (85.95cm), increase number of primary branches (10.55) and secondary branches (33.00), stem diameter (1.88cm), fresh weight of the plant (363.02 g) and dry weight of the plant (63.29 g), flowering span (49.67 days), number of flowers per plant (40.67), weight of single flower (5.75 g), weight of flowers per plant (237.99 g), flowers yield per plot (5.95kg) and flowers yield per hectare (17.63 t/ha) was noted in the treatment of vermi compost @6 tonne ha$^{-1.}$ However, without vermi compost (control) were recorded minimum days to opening first flower (51.36 days), days to 50% flowering (64.18 days) shelf life of flower (3.88 days) and vase life of flower (6.72 days). The interaction between the different levels of nitrogen and vermin compost failed to depict any significant effect on recorded characters.

Keywords: Nitrogen, vermi compost, marigold, double orange

Introduction
African marigold (*Tagetes erecta* L.) is one of the important commercial flowers of India and being grown for its spectacular flowers, brilliant colours, delightful appearance, myriads of sizes, shapes, forms, *etc*. Its origin is Central to Southern America especially Mexico, from there it reached to Spain and became popular by the name 'Rose of Indies'. Around 56 species contributes to the genus *Tagetes.* In India marigold ranks first among the loose flowers area followed by chrysanthemum, jasmine, tuberose, crossandra and barleria (Bhattacharjee, 2002) [4]. Today, there is huge demand for natural colours of marigold, calendula, hibiscus, gomphrena, petunia, *etc*., in the International market. Marigold is one such potential flower crops for natural colour extraction.

Fertilizers mainly nitrogen, phosphorus and potash play a leading role in maximizing the flower production. Under Saurashtra agro-climatic conditions, information on nitrogen, phosphorus and potash requirement of this crop is already worked out earlier, but worked on combined effect with Nitrogen and Vermi compost is limited. Nitrogen is the most commonly deficient nutrient in the soil and gives considerable response to this crop. It has the quickest and the most pronounced effect on plant growth and development and ultimately on flower

yield. It is an integral part of chlorophyll, which is essential for photosynthesis. Nitrogen is essential constituent of protein and is present in many other compounds of physiological importance in plant metabolism such as nucleotide, phosphatides, alkaloids, enzymes, hormones and vitamins, *etc*. Vermi compost is a rich mixture of major and minor plant nutrients. On an average vermi compost contains 3% nitrogen, 1% phosphorus and 1.5% potassium. Vermi compost is an excellent base for establishment of free living and symbiotic microbes. Application of vermi compost increases the total microbial population of the nitrogen fixation bacteria. It gives a quick response compared to ordinary compost or farmyard manure. It also increases the availability of phosphorus and nitrogen and improves microbial action in the soil. The use of vermi compost in place of other organic fertilizer helps to overcome the problem of scarcity of organic fertilizer like FYM.

The research based information on nutrient requirement of marigold is meager. The use of vermi compost in place of other organic fertilizer helps to overcome the problem of scarcity of organic fertilizer like FYM. Uses of vermi compost have been found effective to increase growth and production of marigold. Present experiment is undertaken in order to study the "Effect of nitrogen and vermi compost application on growth, flower yield and shelf life of flower in marigold (*Tagetes erecta* L.) cv. Double Orange".

Materials and Methods

The field experiment was carried out at Jambuvadi Farm, Plot No. 2 (B) Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat during the December, 2016 to May, 2017. The experiment carried out in Factorial Randomized Block Design (FRBD) with three replications and sixteen treatment combinations. The treatment comprised with four levels of Nitrogen *viz*., 0kg ha^{-1}, 150kg ha^{-1}, 200kg ha^{-1}, 250kg ha^{-1} and four levels of vermi compost 0tonne ha^{-1}, 2tonne ha^{-1}, 4tonne ha^{-1} and 6tonne ha^{-1}.

As per treatments, half doses of nitrogen were applied as basal dose before transplanting. The remaining half dose of nitrogen was given as a top dress on 30 days after transplanting. Nitrogen was applied in the form of urea. However, vermi compost was applied as basal dose before transplanting as per treatments.

Farm Yard Manure (FYM) was applied at the rate of 20tonnes per hectare to the plots uniformly and incorporated into the soil before transplanting of marigold seedling. Full dose of phosphorus and potassium were applied as basal dose before transplanting. Phosphorus and potassium were applied in the form of single super phosphate and murate of potash, respectively. Nitrogen applied as per the treatment in the form of urea.

Result and Discussion

Vegetative growth character

Data revealed in Table-1 clearly indicated that the different treatments of nitrogen and Vermi compost was effective in influencing various growth characters *viz*. plant height, number of branches, stem diameter and fresh and dry weight of plant. Significantly maximum plant height, number of primary and secondary branches per plant, stem diameter, fresh and dry weight of plant in marigold were recorded N_3 (250kg/ha) (34.72, 55.07 & 85.39cm, 11.34 & 33.78, 2.03cm, 371.60 g and 68.03 g respectively). Increase in plant height by increasing the dose of nitrogen might be attributed to the possible role of nitrogen in increasing vegetative growth as it is an important constituent of proteins which help in improving structural parameters. The increase in plant height might be due to greater uptake of nutrients into the plant system which involved in cell division, cell elongation as well as protein synthesis which ultimately enhanced the stem length and vegetative growth. Nitrogen increase metabolites and rate of photosynthesis in plants which enables the plant to have quick and better vegetative growth. Increase in plant height due to increased nitrogen application is in close proximity with the findings of Rajbeer *et al.* (2009) [17], Kishor *et al.* (2010) [9] and Polara *et al.* (2014) [16] in marigold; Deshmukh *et al.* (2006) [6] and Satar *et al.* (2012) [19] in chrysanthamum;

Similarly, different level of vermi compost significantly maximum plant height, number of primary and secondary branches per plant, stem diameter, fresh and dry weight of plant in marigold were recorded V_3(6tonne ha^{-1}) (34.53, 55.11 & 85.95cm, 10.55 & 33.00, 1.88cm, 363.02g & 63.29g, respectively) as compared to each other treatments. The significant increase with increasing dose of vermi compost may be due to the fact that it contains a lot of beneficial microorganisms as well as humic acid and many factors which contribute to plant growth. Organic material may be regulates oxidation-reduction enzyme reaction of the metabolism in plants. There is an enhancement in cell multiplication and cell elongation resulting in more plant height. Vermi compost besides improving soil texture also improves soil fertility. It contains various other substances that contribute towards increasing production. The above results were in confirmation with Atiyeh *et al.* (2000) [3] and Ajitkumar (2002) [4] in marigold; Hidalgo and Harkness (2002) in chrysanthemum; Sindhu *et al.* (2009) [21] in gerbera. The treatment combination of different levels of nitrogen and Vermi compost resulted non-significant.

Flowering Quality Parameters

Data revealed in Table-2 and 3 clearly indicated that the different treatments of nitrogen and Vermi compost was effective in influencing various flower quality parameters such as shelf life of flower and vase life of flower. Significantly, minimum days to flower opening to opening first flower, days to 50% flowering, shelf life of flower and vase life of flower were recorded in the treatment of 0kg ha^{-1} nitrogen (Control) (50.18, 62.98, 4.03 and 6.80 days, respectively). The role of nitrogen in influencing the flowering can be explained on the basis of the concept that proper amount of stored carbohydrates are necessary for inducing the plants from vegetative phase to flowering. In present case, the nitrogen at higher levels might have favoured the amino acid metabolism of expenses of carbohydrate metabolism resulting in delayed flowering with the application of higher doses nitrogen. The results are in conformation with the findings of Anuradha *et al.* (1990) [2], and Sehrawat *et al.* (2003) [20] in marigold; Kumar *et al.* (2002) [8] and Muktanjali *et al.* (2004) [12] in china aster. This may be due to the reason that higher dose of nitrogen keeps the flower soft and succulent in texture and this type of texture of flowers resulted in higher and faster respiration and dehydration. This finding corroborate results also obtained by Tossar (1989) [22] in gaillardia.

Similarly, different level of vermi compost significantly minimum days to flower opening to opening first flower, days to 50% flowering, shelf life of flower and vase life of flower were recorded in the treatment of 0 t ha^{-1} vermi compost (Control) (51.36, 64.18, 3.88 and 6.72 days, respectively).

The treatment combination of different levels of nitrogen and Vermi compost resulted non-significant. The increase doses of nitrogen resulted delayed the emergence of flower bud and nitrogen promotes vegetative growth, there by delayed flowering. The lowest period to emergence of bud and 50 percent flowering under application of vermi compost might be due to that the plant growth promoting substances improving physiology of plant growth. Application of vermi compost caused the earlier bud initiation and more flowering by enhancing soil fertility and moisture retention capacity of soil. Similar result also reported by Patel *et al.* (2008) [15] and Naik *et al.* (2008) [13] in marigold. This may be due to the reason that higher dose of vermi compost keeps the flower soft and in texture and this type of texture of flowers resulted in higher and faster respiration and dehydration. Similar result was obtained by Patel *et al.* (2008) [15] in marigold and Nethra *et al.* (1999) [14] in china aster.

Yield Parameters

The yield parameters *viz.* flowering span, number of flower per plant, weight of single flower, weight of flower per plant, flower yield per plot and flower yield per hectare were recorded significantly maximum with N_2 (200kg/ha) (49.33 days, 41.29, 6.03g, 251.98g, 6.30g, and 18.66t/ha respectively) and V_3 (6 tonne ha^{-1}) (49.67 days, 40.67, 5.75g, 237.99g, 5.95kg and 17.63t/ha respectively). (Table 3). It might be due to application of nitrogen at higher level produced vigorous plants with improved flowering characters which might have resulted in higher rate of photosynthesis that reflected in increased in number of flowers per plant, size of flower and ultimately enhanced the flower yield. Similar result was obtained by Ravindran *et al.* (1986) [18], Anuradha *et al.* (1990) [2] and Hameed and sekar (1999) in marigold and Mishra (1998) [11] in gaillardia.

Similarly, Vermi compost yield parameters, Increase in flower weight might be due to active cell elongation in the flower which resulted in increased flower size and definitely increased weight of flower. Vermi compost supplied available nutrient directly to the plant and also had solubilizing effect on fixed form of nutrients in the soil proved additional nutrients to the plant as well as improved the physical and biological properties of soil and enhance plant growth and flowers and flower size. Many authors have corroborated with the observations of Chauhan *et al.* (2005) in marigold.

Table 1: Effect of nitrogen and vermi compost on vegetative growth parameters of marigold cv. 'Double Orange'

Treatments	Plant height (cm)			No. of branches		Stem diameter (cm)	Fresh weight of plant (g)	Dry weight of plant (g)
	30 DAT	60 DAT	90 DAT	Primary	Secondary			
Level of Nitrogen (N)								
N_0- 0kg/ha	30.05	49.30	77.96	8.24	29.09	1.01	320.02	49.45
N_1- 150kg/ha	32.96	52.91	82.59	9.53	31.37	1.22	345.07	57.19
N_2- 200kg/ha	33.90	54.06	83.95	10.11	32.12	1.40	353.30	60.68
N_3- 250kg/ha	34.72	55.07	85.39	11.34	33.78	2.03	371.60	68.03
S.Em.±	0.78	1.08	1.66	0.34	0.77	0.05	8.46	2.06
C.D. at 5%	2.24	3.13	4.78	0.99	2.22	0.15	24.44	5.94
Level of Vermi compost (V)								
V_0- 0 t/ha	31.02	50.17	78.35	8.78	29.30	0.98	322.34	52.70
V_1- 2 t/ha	32.73	52.58	82.12	9.81	31.81	1.31	349.90	58.86
V_2- 4 t/ha	33.36	53.47	83.46	10.08	32.25	1.48	354.73	60.49
V_3- 6 t/ha	34.53	55.11	85.95	10.55	33.00	1.88	363.02	63.29
S.Em.±	0.78	1.08	1.66	0.34	0.77	0.05	8.46	2.06
C.D. at 5%	2.24	3.13	4.78	0.99	2.22	0.15	24.44	5.94
Interaction (N X V)								
S.Em.±	1.55	2.17	3.31	0.69	1.54	0.10	16.92	4.11
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS
CV%	8.16	7.11	6.96	12.10	6.43	12.50	8.43	12.10

Table 2: Effect of nitrogen and vermi compost on flowering quality parameters of marigold cv. 'Double Orange'

Treatments	Shelf life of flower (Days)	Vase life of flower (Days)
Level of Nitrogen (N)		
N_0- 0kg/ha	4.03	6.80
N_1- 150kg/ha	3.74	6.61
N_2- 200kg/ha	3.52	6.41
N_3- 250kg/ha	2.93	5.74
S.Em.±	0.14	0.18
C.D. at 5%	0.41	0.51
Level of Vermi compost (V)		
V_0- 0 t/ha	3.88	6.72
V_1- 2 t/ha	3.65	6.55
V_2- 4 t/ha	3.46	6.40
V_3- 6 t/ha	3.22	5.88
S.Em.±	0.14	0.18
C.D. at 5%	0.41	0.51
Interaction (N X V)		
S.Em.±	0.28	0.35
C.D. at 5%	NS	NS
CV%	13.69	9.62

Table 3: Effect of nitrogen and vermi compost on yield parameters of marigold cv. 'Double Orange'

Treatments	Days to first flower opening	Days to 50% flowering	Flowering Span (Days)	Number of flowers per plant	Weight of single flower (g)	Weight of flowers per plant (g)	Flowers yield per plot (kg)	Flowers yield per hectare (t/ha)
Level of Nitrogen (N)								
N_0-0kg/ha	50.18	62.98	45.10	34.42	4.58	162.07	4.05	12.00
N_1- 150kg/ha	51.84	64.66	47.86	38.53	5.18	201.44	5.04	14.92
N_2-200kg/ha	53.48	66.29	49.33	41.29	6.03	251.98	6.30	18.66
N_3-250kg/ha	57.34	70.15	48.59	39.89	5.49	221.69	5.54	16.42
S.Em.±	1.12	1.42	0.92	1.01	0.19	8.11	0.20	0.60
C.D. at 5%	3.22	4.11	2.65	2.93	0.55	23.42	0.59	1.74
Level of Vermi compost (V)								
V_0-0 t/ha	51.36	64.18	45.37	34.45	4.60	161.83	4.05	11.99
V_1-2 t/ha	51.92	64.73	47.48	39.05	5.42	215.02	5.38	15.30
V_2-4 t/ha	52.80	65.61	48.36	39.96	5.51	222.34	5.56	16.47
V_3-6 t/ha	56.76	69.56	49.67	40.67	5.75	237.99	5.95	17.63
S.Em.±	1.12	1.42	0.92	1.01	0.19	8.11	0.20	0.60
C.D. at 5%	3.22	4.11	2.65	2.93	0.55	23.42	0.59	1.74
Interaction (N X V)								
S.Em.±	2.23	2.84	1.83	2.03	0.38	16.22	0.41	1.20
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS
CV%	7.26	7.46	6.65	9.12	12.35	13.42	13.45	13.44

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