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IMPACT OF BIOFERTLIZERS AND ORGANIC MANURE WITH PLANT GROWTH RETARDANT ON FLOWER QUALITY AND ECONOMICS OF AFRICAN MARIGOLD (*TAGETES ERECTA* L.) CV. PUSA NARANGI GAINDA

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Abstract

The present investigation was conducted at Horticulture Research Farm, Department of Horticulture, Kulbhaskar Ashram Post Graduate College, Prayagraj, (U.P.) during the year 2016-2017 and 2017-18. The experiment was laid out in Randomized Block Design with three replications consisted of 36 treatments with control. The four levels of Azotobacter, three levels of PSB and three levels of Vermicompost with fixed dose of cycocel (2- chloroethyle triemethyle ammonium chloride) along with control was taken. The results revealed that application of the treatment T_{22}(Azotobacter- 500 ml/ha, PSB- 500 ml/ha and Vermicompost- 2.50 t/ha) was found most effective as it gave highest flower size (8.72 cm), maximum oil percentage of flower (0.44%) and highest C.B. ratio (1:4.10). Whereas application of T_{26} (Azotobacter- 500 ml/ha, PSB- 1000 ml/ha and Vermicompost- 5.00 t/ha) produced maximum number of disk florets (68.20), ratio of disk and ray florets (1:4.04) and vase life of cut flower (8.80 days). Treatment T_{25} showed maximum length of flower stalk (8.68 cm) and number of ray florets (192.20) were recorded under T_{34} (Azotobacter- 750 ml/ha, PSB- 1000 ml/ha and Vermicompost- 2.50 t/ha).

Keywords*:* Biofertilizers, Azotobacter, African marigold (*Tagetes erecta* L.), PGR, Vermicompost, Cycocel.

Introduction

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. It is native of central and South America especially Mexico and belongs to the family Asteraceae (Compositae). There are 33 species of genus *Tagetes* in which few are important *viz*., *Tagetes erecta, T. patula ,T. tenuifolia, T. luicida* (sweet scented marigold), *T. sarmetosa* (climbing marigold), *T. lacera*, *T. lemmmoni*, *T. minuta*, *T. filifolia* (Irish lace). There are two species, which are commercially grown viz. *Tagetes erecta* L. (African marigold) and *Tagetes patula* L. (French marigold). This flower is extensively used for decoration in various religious and social functions, beautification of garden and for other commercial purposes likes extraction of perfume. In Mexico and Latin America, marigold flowers are used to decorate household alters to celebrate all saint and souls day (De and Bhattacharjee, 2011). Marigold is known as different name in different region e.g. friendship flower in United state, student enablement (student flower) in Germany, dead flower in Latin America and shayapatri in Nepal.

Its popularity, wide availability and multifarious uses, in no way is comparable with other flowers. It has a short duration to produce marketable flowers with wide spectrum of attractive colours, shape, size and good keeping quality, hence, attracted the attention of flower growers. It is use as cut-flower for vase decoration and other arrangement besides loose flower for making garlands, decoration of buildings, gates, pandals during social functions, marriage ceremonies, worshipping and for floral rangoli. As garden plants for bedding and pot culture, herbaceous border, hanging baskets and window boxes, marigold is commonly grown in every home garden, parks and garden throughout the country. The uses of marigold are many fold, often referred to as, "Versatile crop with golden harvest". Marigolds produce thiopenes, which are toxic to nematodes and used as trap crop in tomato, brinjal, tobacco etc (Raghava, 2000). It is not only cultivated as ornamental cut flower and landscape plant but also a source of carotenoid pigment for poultry feed to intensify yellow colour of egg yolks and broiler skin. Apart from poultry industry, marigold dye is also used in textile, pharmaceutical industries, food supplements, cosmetics etc as they offer several advantages over synthetic dyes from natural point of view, safety and eco-friendly in nature (Naik *et al*., 2004).

Due to raising cost of chemical fertilizers and problems of environmental pollution it has become imperative to arrive at an integrated nutrient management practices for marigold to achieve quality flowers at economical use of plant nutrients. Hence, an attempt is made to reduce the amount of nitrogenous and phosphatic fertilizers by substituting with biofertilizer and organic manure. This crop is a heavy feeder of nutrients, at present the nutrients are supplied through

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chemical fertilizers. Indiscriminate and continuous use of chemical fertilizer in intensive cropping system has led to an imbalance of nutrients in soil which has an adverse effect on soil health and also affecting flower quality. Commercial exploitation of the flowers for xanthophylls extraction has made this flower crop much more popular among the flower growers and industries.

Materials and Methods

An investigation was carried out during winter season of the year 2016-2017 and 2017-18 at Horticulture Research Farm, Department of Horticulture, Kulbhaskar Ashram P.G. College, Prayagraj (U.P.). The experiment was laid out in Randomized Block Design with three replications and 36 treatments with control. Under treatments as biofertilizers four levels of Azotobacter (0,250,500 and750 ml/ha) and three levels of PSB (0, 500 and 1000 ml/ha) was given as seedling treatment and three levels of vermicompost (0, 2.5, 5.0 t/ha) will also be supplemented as organic manures during field preparation in selected plots. Cycocel @ 400 ppm was given as foliar feeding at 30 day after transplanting of seedling in each treatment except control as plant growth retardants.

The treatments detail is as follows, T_0 (control), T_1 (Vermicompost- 2.50 t/ha), T_2 (Vermicompost- 5.00 t/ha), T_3 (PSB- 500 ml/ha), T_4 (PSB- 500 ml/ha + Vermicompost- 2.50 t/ha), T_5 (PSB- 500 ml/ha + Vermicompost- 5.00 t/ha), T_6 (PSB- 1000 ml/ha), T_7 (PSB- 1000 ml/ha + Vermicompost- 2.50 t/ha), T_8 (PSB- 1000 ml/ha + Vermicompost- 5.00 t/ha), T_9 (Azotobacter- 250 ml/ha), T_{10} (Azotobacter- 250 ml/ha + Vermicompost- 2.50 t/ha), T_{11} (Azotobacter- 250 ml/ha + Vermicompost- 5.00 t/ha), T_{12} (Azotobacter- 250 ml/ha + PSB- 500 ml/ha), T_{13} (Azotobacter- 250 ml/ha + PSB- 500 ml/ha + Vermicompost- 2.50 t/ha), T_{14} (Azotobacter- 250 ml/ha + PSB- 500 ml/ha + Vermicompost- 5.00 t/ha), T_{15} (Azotobacter- 250 ml/ha + PSB- 1000 ml/ha), T_{16} (Azotobacter- 250 ml/ha + PSB- 1000 ml/ha + Vermicompost- 2.50 t/ha), T_{17} (Azotobacter- 250 ml/ha + PSB- 1000 ml/ha + Vermicompost- 5.00 t/ha), T_{18} (Azotobacter- 500 ml/ha), T_{19} (Azotobacter- 500 ml/ha + Vermicompost- 2.50 t/ha), T_{20} (Azotobacter- 500 ml/ha + Vermicompost- 5.00 t/ha), T_{21} (Azotobacter- 500 ml/ha + PSB- 500 ml/ha), T_{22} (Azotobacter- 500 ml/ha + PSB- 500 ml/ha + Vermicompost- 2.50 t/ha), T_{23} (Azotobacter- 500 ml/ha + PSB- 500 ml/ha + Vermicompost- 5.00 t/ha), T_{24} (Azotobacter- 500 ml/ha + PSB- 1000 ml/ha), T_{25} (Azotobacter- 500 ml/ha + PSB- 1000 ml/ha + Vermicompost- 2.50 t/ha), T_{26} (Azotobacter- 500 ml/ha + PSB- 1000 ml/ha + Vermicompost- 5.00 t/ha), T_{27} (Azotobacter- 750 ml/ha), T_{28} (Azotobacter- 750 ml/ha + Vermicompost- 2.50 t/ha), T_{29} (Azotobacter- 750 ml/ha + Vermicompost- 5.00 t/ha), T_{30} (Azotobacter- 750 ml/ha + PSB- 500 ml/ha), T_{31} (Azotobacter- 750 ml/ha + PSB- 500 ml/ha + Vermicompost- 2.50 t/ha), T_{32} (Azotobacter- 750 ml/ha + PSB- 500 ml/ha + Vermicompost- 5.00 t/ha), T_{33} (Azotobacter- 750 ml/ha + PSB- 1000 ml/ha), T_{34} (Azotobacter- 750 ml/ha + PSB- 1000 ml/ha + Vermicompost- 5.00 t/ha) and T_{35} (Azotobacter- 750 ml/ha + PSB- 1000 ml/ha + Vermicompost- 5.00 t/ha). Flower characters *viz.,* Size of flower, Length of flower stalk (cm), Number of ray florets, Number of disk florets, Vase life of cut flower, Oil percentage, Ratio of Disk and Ray florets and C.B. ratio were recorded from five plants which were randomly selected and labelled in each plot of treatment.

Results and Discussion

Size of flower (cm)

The flowers quality characters showed significant responses to different treatments of biofertilizers and organic manure with plant growth retardant presented in Table No. 1. On the basis of pooled data, the maximum diameter of flower (8.72 cm) was noticed in T_{22} which contains Azotobacter- 500 ml/ha, PSB- 500 ml/ha and Vermicompost- 2.50 t/ha followed by T_{23} (8.49 cm) and T_{31} (8.28 cm) while, minimum flower diameter (5.30 cm) was found under control (5.30 cm). The positive effect of Azotobacter, PSB and Vermicompost on flower diameter has been reported in marigold by Pushkar and Rathore (2011), Kaushik *et al.* (2013) and Naidu *et al.* (2014).

Length of flower stalk

Integrated use of Azotobacter, PSB and Vermicompost effect on flower stalk's length is concerned; the integrated nutrient management with PGR resulted in improved flower quality on pooled data basis. Treatment T_{25} (Azotobacter- 500 ml/ha + PSB- 1000 ml/ha + Vermicompost- 2.50 t/ha) recorded highest length of flower stalk (8.68 cm) followed by T_{32} (8.56 cm) and T_{31} (8.47 cm) whereas, lowest length of flower stalk (6.16 cm) was recorded with control (6.16 cm) presented in Table No. 1.

Number of ray florets

The pooled data showed in Table No.1 that maximum number of ray florets (192.20) was recorded in T_{34} (Azotobacter- 750 ml/ha + PSB- 1000 ml/ha + Vermicompost- 5.00 t/ha) followed by T_{35} (190.00) and T_{22} (178.90) whereas, control produced minimum number of ray florets (98.30) per flower. Similar, reports were made by Das and Mishra (2005), Kaushik *et al.* (2013) and Kumar *et al.* (2017)

Number of disk florets

Maximum number of disk florets per flower (68.20) was reported with T_{26} (Azotobacter- 500 ml/ha + PSB- 1000 ml/ha + Vermicompost- 5.00 t/ha) followed by T_{21} (65.60) and T_7 (64.90) while, number of minimum disk florets per flower was noticed under control (42.30) presented in Table No.1 on pooled data of both the years of experiment.

Vase life of cut flower

The maximum vase life of flowers was observed under T_{26} (8.80 days) followed by T_{23} (8.50 days) and T_{35} (8.05 days) on the basis of pooled data of both the years and showed in Table No.1. While minimum keeping quality was observed with T_{24} (5.90 days). This findings was in agreement with the findings of Joshi and Barad (2002), Yadav *et al.* (2018), Goutham Kishore *et al.* (2018) in Marigold, Nethra *et al.* (1999), Parmar (2007), Kumar *et al*. (2016), Sharma *et al*. (2017), Sathyanarayana *et al.* (2017) in China aster and Pandey *et al.* (2018) in chrysanthemum.

Oil percentage

The data presented in Table No. 1 clearly indicate that the significantly highest oil content of flower (0.44%) was reported with T_{22} (Azotobacter- 500 ml/ha + PSB- 500 ml/ha + Vermicompost- 2.50 t/ha) followed by T_{35}(0.43%), T_{34} (0.42) and T_{23} (0.42 %) whereas, lowest oil content in flower (0.26 %) was weighted under T_1 (control). These findings confirmed those reported by Kazemi *et al.* (2014), Girwani *et al.* (1990).

Ratio of Disk and Ray florets

The combined application of biofertilizers and organic manures significantly increased ratio of disk and ray florets (1:4.04) under treatment T_{26} (Azotobacter- 500 ml/ha + PSB- 1000 ml/ha + Vermicompost- 5.00 t/ha) followed by treatment T_{34} (1:3.92), T_{22} (1:3.89) and T_{25} (1:3.61). While minimum ratio of disk and ray florets (1:1.51) was observed under control, which is presented in Table No.1.

C.B. ratio

Thus, the results have proved on pooled data basis the application of treatment combinationT_{22} (Azotobacter- 500 ml/ha + PSB- 500 ml/ha + Vermicompost- 2.50 t/ha) is most effective (1:4.10) in enhancing C.B. ratio of African marigold (*Tagetes erecta* L.) followed by treatment T_{34} (1:3.74), T_{31} (1:3.71) and T_{35} (1:3.70) due to increase in number of flowers bearing branches, number of flower per plant, Average weight of flower and size of flower presented in Table 1. These results are also similar with Verma et al. (2011) in marigold, Meshram *et al*. (2008) in chrysanthemum and Deshmukh *et al.* (2008) in Gaillardia.

Conclusion

It was concluded from trial that the various levels of integrated nutrients used from different sources in the experiment, the treatment T_{22}[Azotobacter- 500 ml/ha + PSB- 500 ml/ha + Vermicompost- 2.50 t/ha] was found to be the best in increasing flower quality and economics of African marigold (*Tagetes erecta* L.) cv. 'Pusa Narangi Gainda' under field condition.

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Table 1: Effect of biofertilizers and organic manures on flower quality and economics of African marigold

T	Size of flower (cm)			Length of flower stalk (cm)			Number of ray florets			Number of disk florets			Vase life of cut flower			Oil percentage			Ratio of Disk and Ray florets			C.B. ratio		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_0	5.24	5.35	5.30	6.05	6.28	6.16	93.80	102.80	98.30	37.20	47.40	42.30	5.80	6.70	6.25	0.24	0.29	0.26	1.50	1.52	1.51	1.85	2.08	1:1.96
T_1	6.18	6.26	6.22	7.15	7.62	7.38	92.40	143.80	118.10	59.00	63.20	61.10	6.60	7.20	6.90	0.29	0.37	0.33	1.62	2.23	1.92	2.01	2.34	1:2.17
T_2	7.18	7.28	7.23	6.85	7.62	7.23	118.20	153.20	135.70	43.20	59.40	51.30	6.50	6.80	6.65	0.26	0.28	0.27	2.00	2.27	2.13	2.01	2.15	1:2.08
T_3	5.28	5.46	5.37	6.75	6.92	6.83	104.80	134.80	119.80	53.40	63.00	55.60	6.20	6.60	6.40	0.30	0.32	0.31	1.64	1.85	1.74	2.64	3.07	1:2.85
T_4	6.28	6.69	6.73	7.86	7.90	7.88	129.80	135.80	132.80	57.00	64.20	60.60	7.40	7.80	7.60	0.31	0.38	0.34	2.06	2.03	2.04	2.89	3.01	1:2.95
T_5	7.28	6.71	7.39	7.83	8.05	7.94	138.60	179.80	159.20	59.00	67.40	63.20	6.80	7.30	7.05	0.33	0.40	0.36	2.37	2.62	2.49	2.53	2.60	1:2.56
T_6	6.14	7.34	6.74	7.37	6.52	6.94	129.20	137.20	133.20	47.00	57.80	52.40	6.40	7.80	7.10	0.29	0.32	0.30	2.66	2.37	2.51	2.53	2.64	1:2.54
T_7	6.28	6.68	6.48	7.69	7.94	7.81	135.80	167.60	151.70	63.00	66.80	64.90	6.20	7.60	6.90	0.31	0.39	0.35	2.30	2.65	2.47	2.76	2.80	1:2.75
T_8	7.28	7.48	7.38	8.36	7.52	7.94	120.40	157.80	139.10	58.40	68.40	63.40	7.60	8.20	7.90	0.32	0.33	0.32	2.78	2.65	2.71	2.17	2.56	1:2.50
T_9	8.16	6.52	7.34	6.14	6.38	6.26	96.40	183.80	140.10	54.80	54.20	54.50	6.60	6.60	6.60	0.26	0.29	0.27	1.66	2.50	2.08	2.89	2.57	1:2.55
T_{10}	7.16	7.26	7.21	8.28	6.95	7.61	109.40	173.80	141.60	45.20	44.60	44.90	7.20	7.50	7.35	0.31	0.33	0.32	2.11	3.23	2.67	3.18	2.85	1:2.80
T_{11}	7.20	7.62	7.41	7.86	8.05	7.95	118.00	137.80	127.90	47.00	63.40	55.20	6.80	7.10	6.95	0.26	0.38	0.32	1.97	2.15	2.06	3.14	2.29	1:2.23
T_{12}	6.58	6.80	6.69	7.22	7.52	7.37	183.80	162.80	173.30	57.80	57.80	60.60	6.30	7.00	6.65	0.27	0.30	0.28	3.75	2.90	3.32	2.94	3.16	1:3.02
T_{13}	7.82	7.86	7.84	6.55	7.58	7.06	148.00	173.80	160.90	55.20	67.80	61.50	7.20	7.30	7.25	0.34	0.42	0.38	2.57	2.97	2.77	3.29	3.32	1:3.25
T_{14}	5.28	6.48	5.88	6.58	6.85	6.71	125.80	154.00	139.90	59.60	56.00	57.80	6.40	7.90	7.15	0.24	0.37	0.30	2.59	2.84	2.71	3.54	3.27	1:3.20
T_{15}	6.56	6.86	6.71	6.85	6.86	6.85	136.20	139.00	137.60	53.60	52.40	53.00	6.20	7.60	6.90	0.29	0.32	0.30	2.73	2.01	2.37	3.06	3.44	1:3.19
T_{16}	7.30	7.46	7.38	7.72	8.26	7.99	145.00	163.40	154.20	39.60	52.20	45.90	7.70	8.00	7.85	0.25	0.37	0.31	2.95	3.20	3.07	2.91	3.48	1:3.38
T_{17}	7.44	6.48	6.96	8.04	8.48	8.26	132.40	167.40	149.90	48.40	69.00	58.70	7.50	8.40	7.95	0.40	0.43	0.41	2.81	3.08	2.94	3.14	3.63	1:3.58
T_{18}	7.74	7.84	8.08	7.20	7.64	7.42	136.80	157.20	147.00	49.80	51.00	50.40	6.60	8.50	7.55	0.37	0.39	0.32	2.36	2.47	2.41	3.06	3.26	1:3.16
T_{19}	6.08	6.28	6.18	6.67	8.72	7.69	147.80	173.20	160.50	49.00	54.20	51.60	6.50	7.50	7.00	0.41	0.32	0.36	2.67	2.99	2.83	2.91	3.11	1:3.01
T_{20}	6.84	5.94	6.39	7.25	8.62	7.93	128.00	157.20	142.60	48.40	57.80	53.10	6.20	7.90	7.05	0.40	0.33	0.36	2.67	2.31	2.49	3.14	3.35	1:3.24
T_{21}	7.68	6.82	7.25	8.68	7.68	8.16	151.80	184.60	168.20	57.80	73.40	65.60	6.00	6.60	6.30	0.41	0.43	0.30	2.83	3.22	3.02	3.55	3.77	1:3.66
T_{22}	8.62	8. 82	8.72	8.35	8.46	8.40	174.00	183.80	178.90	51.80	53.80	52.80	7.50	8.20	7.85	0.43	0.45	0.44	4.29	3.50	3.89	4.00	4.21	1:4.10
T_{23}	8.28	8.70	8.49	8.26	8.38	8.32	142.60	183.80	163.20	62.50	67.20	64.85	8.20	8.80	8.50	0.39	0.46	0.42	3.04	3.52	3.28	3.50	3.67	1:3.58
T_{24}	8.32	7.76	7.75	6.84	7.15	6.99	141.80	157.40	149.60	49.00	58.40	53.70	5.60	6.20	5.90	0.31	0.37	0.41	2.58	2.58	2.58	3.62	3.64	1:3.63
T_{25}	7.48	8.78	8.13	8.57	8.80	8.68	173.40	184.20	178.80	57.40	54.20	55.80	6.90	7.60	7.25	0.31	0.37	0.34	3.83	3.39	3.61	3.24	3.40	1:3.32
T_{26}	7.18	6.28	6.73	7.76	8.46	8.11	159.00	187.53	173.40	63.80	72.60	68.20	8.70	8.90	8.80	0.29	0.35	0.32	3.87	4.21	4.04	3.07	3.23	1:3.15
T_{27}	7.48	6.96	7.22	7.68	8.26	7.97	145.80	154.00	149.90	51.60	54.20	52.90	6.80	7.50	7.15	0.24	0.32	0.28	2.52	2.59	2.55	2.97	3.11	1:3.04
T_{28}	6.28	7.04	6.66	6.72	7.26	6.99	151.80	180.00	165.90	43.60	57.60	50.60	6.50	6.80	6.65	0.37	0.29	0.33	3.24	3.29	3.26	2.80	2.92	1:2.86
T_{29}	7.28	7.68	7.48	7.88	8.20	8.04	154.40	183.00	168.70	41.00	59.40	50.20	7.30	7.50	7.40	0.34	0.37	0.35	2.89	2.98	2.93	3.14	3.44	1:3.29
T_{30}	7.22	7.28	7.25	7.84	7.92	7.88	162.80	183.80	173.30	57.80	54.60	56.20	6.20	6.50	6.35	0.37	0.42	0.39	3.13	2.91	3.02	3.49	3.69	1:3.59
T_{31}	8.26	8.30	8.28	8.46	8.48	8.47	154.20	197.20	175.70	46.80	61.40	50.45	7.20	7.70	7.45	0.38	0.47	0.42	3.26	3.72	3.49	3.69	3.74	1:3.71
T_{32}	6.34	7.96	7.15	8.26	8.86	8.56	140.20	158.80	149.50	47.80	57.20	52.60	6.40	7.30	6.85	0.42	0.37	0.39	2.98	3.35	3.16	3.23	3.36	1:3.29
T_{33}	8.28	7.84	8.06	8.58	7.87	8.22	146.60	167.00	156.80	52.00	53.00	52.50	6.40	6.50	6.45	0.32	0.40	0.36	2.84	2.89	2.86	3.60	3.70	1:3.65
T_{34}	6.42	7.80	7.11	7.28	7.85	7.56	171.00	213.40	192.20	47.20	57.60	52.40	6.60	8.50	7.55	0.39	0.45	0.42	3.92	3.93	3.92	3.62	3.86	1:3.74
T_{35}	8.06	8.16	8.11	7.68	8.94	8.31	187.40	192.60	190.00	46.80	61.00	53.90	7.80	8.30	8.05	0.42	0.44	0.43	3.03	3.34	3.18	3.63	3.77	1:3.70
SE(d)	**0.29**	**0.32**	**0.22**	**0.41**	**0.39**	**0.28**	**4.39**	**5.36**	**3.46**	**2.18**	**2.68**	**1.73**	**0.31**	**0.32**	**0.22**	**0.04**	**0.03**	**0.03**	**0.19**	**0.22**	**0.14**	**0.19**	**0.20**	**0.14**
C.D. at 5%	**0.58**	**0.64**	**0.43**	**0.80**	**0.77**	**0.55**	**8.68**	**10.62**	**6.82**	**4.32**	**5.31**	**3.41**	**0.62**	**0.64**	**0.44**	**0.08**	**0.06**	**0.05**	**0.38**	**0.42**	**0.28**	**0.38**	**0.40**	**0.27**