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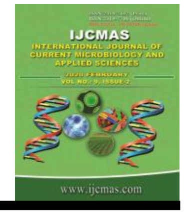

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Effect of Integrated Nutrients Management with Plant Growth Retardant on Flower Quality and Economics of African Marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda

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Keywords

Biofertilizers, *Azotobacter*, African marigold, *Tagetest erecta* L., Integrated Nutrients Management, PGR, Vermicompost, Cycocel

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A B S T R A C T

The present investigation was conducted at Horticulture Research Farm, Department of Horticulture, Kulbhaskar Ashram P.G. 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 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 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), 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) but number of disk florets were observed under T_{35} (Azotobacter- 750 ml/ha, PSB- 1000 ml/ha and Vermicompost- 5.00 t/ha).

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 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. In view of the above facts, the present study entitled, "Effect of integrated nutrient management with PGR on flower quality and economics of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda" was undertaken.

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

Data presented in Table 1 and graphically depicted in Fig. 1, on flowers quality characters, show significant responses to different treatments of biofertilizers and organic manure with plant growth retardant.

The maximum size of flower (8.72 cm) were noticed inT_{22} followed by T_{23} (8.49 cm) and T_{31} (8.28 cm) while, minimum flower size (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).

As far as, effect of integrated use of biofertlizers and Vermicompost on flower stalk length is concerned, the integrated nutrient management resulted in improved flower quality. T_{25} resulted in 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 T_0 (control) presented in Table 1 and Fig. 2.

Table.1 Effect of different doses on flower quality and economics of African marigold

Treatment Number	Notations	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
T_0	A_0 P_0 V_0	5.30	6.16	98.30	42.30	6.25	0.26	1.51	1:1.96
T_1	A_0 P_0 V_1	6.22	7.38	118.10	61.10	6.90	0.33	1.92	1:2.17
T_2	A_0 P_0 V_2	7.23	7.23	135.70	51.30	6.65	0.27	2.13	1:2.08
T_3	A_0 P_1 V_0	5.37	6.83	119.80	55.60	6.40	0.31	1.74	1:2.85
T_4	A_0 P_1 V_1	6.73	7.88	132.80	60.60	7.60	0.34	2.04	1:2.95
T_5	A_0 P_1 V_2	7.39	7.94	159.20	63.20	7.05	0.36	2.49	1:2.56
T_6	A_0 P_2 V_0	6.74	6.94	133.20	52.40	7.10	0.30	2.51	1:2.54
T_7	A_0 P_2 V_1	6.48	7.81	151.70	64.90	6.90	0.35	2.47	1:2.75
T_8	A_0 P_2 V_2	7.38	7.94	139.10	63.40	7.90	0.32	2.71	1:2.50
T_9	A_1 P_0 V_0	7.34	6.26	140.10	54.50	6.60	0.27	2.08	1:2.55
T_{10}	A_1 P_0 V_1	7.21	7.61	141.60	44.90	7.35	0.32	2.67	1:2.80
T_{11}	A_1 P_0 V_2	7.41	7.95	127.90	55.20	6.95	0.32	2.06	1:2.23
T_{12}	A_1 P_1 V_0	6.69	7.37	173.30	60.60	6.65	0.28	3.32	1:3.02
T_{13}	A_1 P_1 V_1	7.84	7.06	160.90	61.50	7.25	0.38	2.77	1:3.25
T_{14}	A_1 P_1 V_2	5.88	6.71	139.90	57.80	7.15	0.30	2.71	1:3.20
T_{15}	A_1 P_2 V_0	6.71	6.85	137.60	53.00	6.90	0.30	2.37	1:3.19
T_{16}	A_1 P_2 V_1	7.38	7.99	154.20	45.90	7.85	0.31	3.07	1:3.38
T_{17}	A_1 P_2 V_2	6.96	8.26	149.90	58.70	7.95	0.41	2.94	1:3.58
T_{18}	A_2 P_0 V_0	8.08	7.42	147.00	50.40	7.55	0.32	2.41	1:3.16
T_{19}	A_2 P_0 V_1	6.18	7.69	160.50	51.60	7.00	0.36	2.83	1:3.01
T_{20}	A_2 P_0 V_2	6.39	7.93	142.60	53.10	7.05	0.36	2.49	1:3.24
T_{21}	A_2 P_1 V_0	7.25	8.16	168.20	65.60	6.30	0.30	3.02	1:3.66
T_{22}	A_2 P_1 V_1	8.72	8.40	178.90	52.80	7.85	0.44	3.89	1:4.10
T_{23}	A_2 P_1 V_2	8.49	8.32	163.20	64.85	8.50	0.42	3.28	1:3.58
T_{24}	A_2 P_2 V_0	7.75	6.99	149.60	53.70	5.90	0.41	2.58	1:3.63
T_{25}	A_2 P_2 V_1	8.13	8.68	178.80	55.80	7.25	0.34	3.61	1:3.32
T_{26}	A_2 P_2 V_2	6.73	8.11	173.40	68.20	8.80	0.32	4.04	1:3.15
T_{27}	A_3 P_0 V_0	7.22	7.97	149.90	52.90	7.15	0.28	2.55	1:3.04
T_{28}	A_3 P_0 V_1	6.66	6.99	165.90	50.60	6.65	0.33	3.26	1:2.86
T_{29}	A_3 P_0 V_2	7.48	8.04	168.70	50.20	7.40	0.35	2.93	1:3.29
T_{30}	A_3 P_1 V_0	7.25	7.88	173.30	56.20	6.35	0.39	3.02	1:3.59
T_{31}	A_3 P_1 V_1	8.28	8.47	175.70	50.45	7.45	0.42	3.49	1:3.71
T_{32}	A_3 P_1 V_2	7.15	8.56	149.50	52.60	6.85	0.39	3.16	1:3.29
T_{33}	A_3 P_2 V_0	8.06	8.22	156.80	52.50	6.45	0.36	2.86	1:3.65
T_{34}	A_3 P_2 V_1	7.11	7.56	192.20	52.40	7.55	0.42	3.92	1:3.74
T_{35}	A_3 P_2 V_2	8.11	8.31	190.00	53.90	8.05	0.43	3.18	1:3.70
SE(d)		**0.22**	**0.28**	**3.46**	**1.73**	**0.22**	**0.03**	**0.14**	**0.14**
C.D. at 5 %		**0.43**	**0.55**	**6.82**	**3.41**	**0.44**	**0.05**	**0.28**	**0.27**

Vase life study and oil extraction by Clevenger apparatus of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gaida

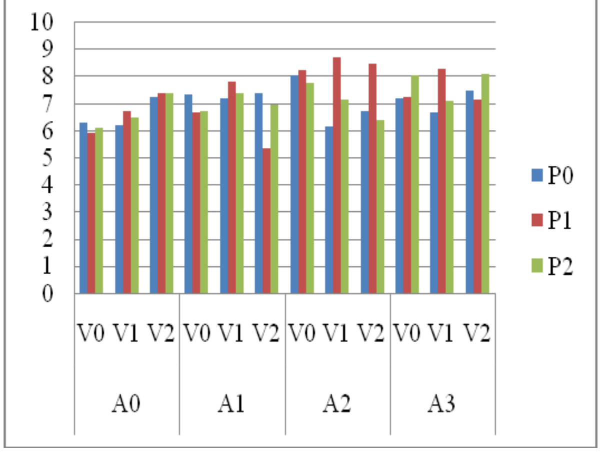


Fig. 1 Effect of interaction of Azotobacter, PSB and Vermicompost on size of flower

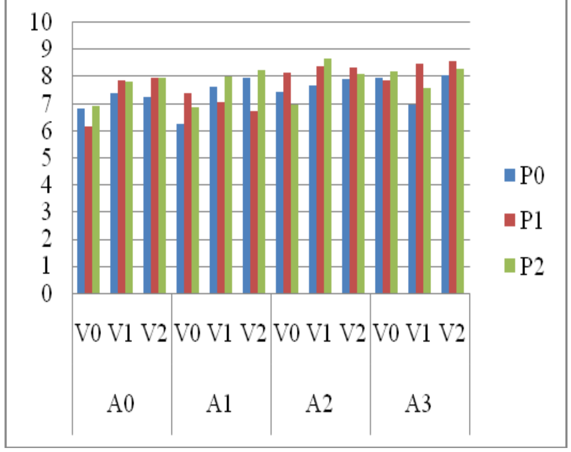


Fig. 2 Effect of interaction of Azotobacter, PSB and Vermicompost on length of flower stalk

Fig. 3 Effect of interaction of Azotobacter, PSB and Vermicompost on number of ray florets

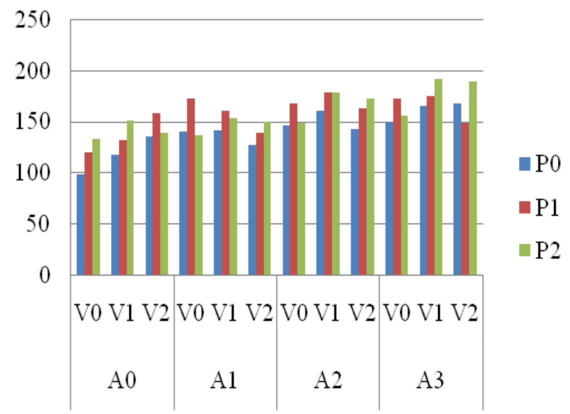


Fig. 4 Effect of interaction of Azotobacter, PSB and Vermicompost on number of disk florates

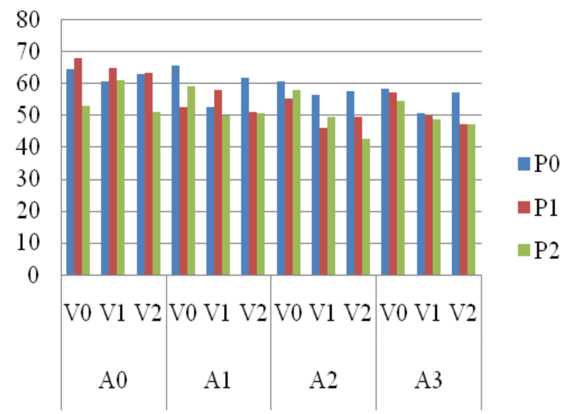


Fig. 5 Effect of interaction of Azotobacter, PSB and Vermicompost on vase life of flower

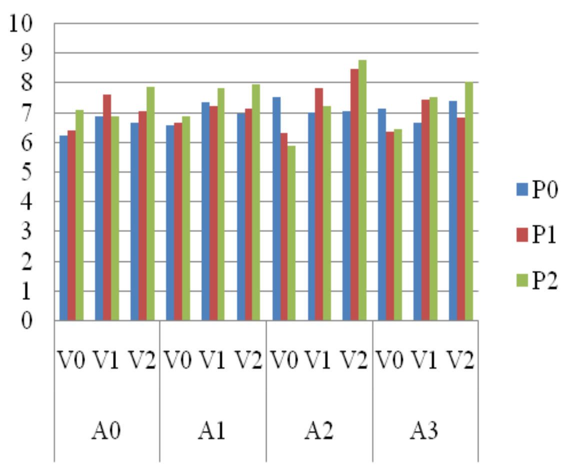


Fig. 6 Effect of interaction of Azotobacter and PSB on oil percent

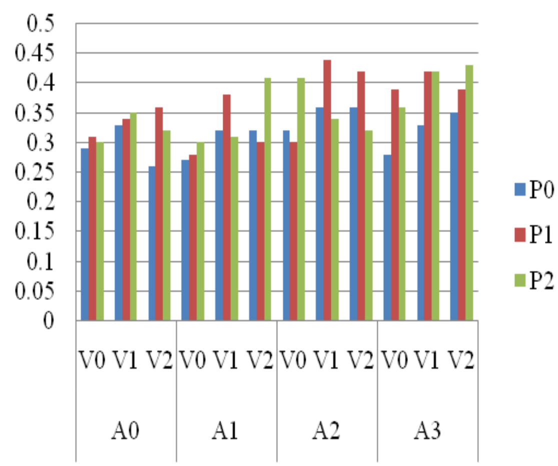


Fig. 7 Effect of interaction of Azotobacter, PSB and Vermicompost on ratio of disk and ray florets

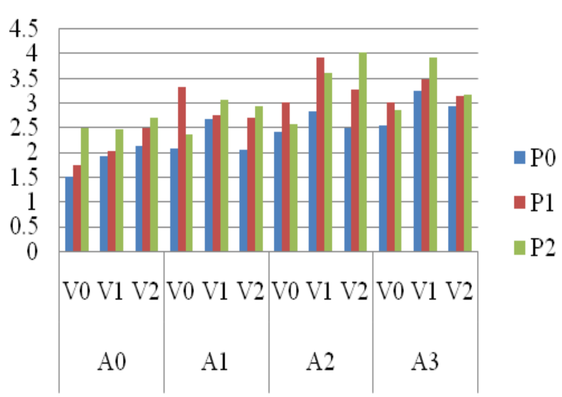
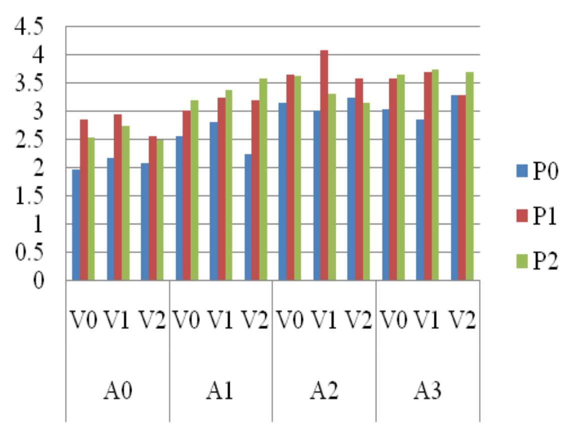


Fig. 8 Effect of interaction of Azotobacter, PSB and Vermicompost on C.B. ratio



The results showed in Table 1 and Fig. 3 that maximum number of ray florets (192.20) was recorded in T_{34} followed by T_{35} (190.00) and T_{22} (178.90) whereas, control plants produced with minimum number of ray florets (98.30). Similar, reports were made by Das and Mishra (2005), Kaushik *et al.*, (2013) and Kumar *et al.*, (2017) and maximum number of disk florets per flower (68.20) was reported with T_{26} followed by T_{21} (65.60) and T_7 (64.90) while, number of minimum disk florets per flower (42.30) was noticed under T_0 (control) presented in Table 1 and Fig. 4.

Pooled data of both the years reveals that 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) showed in Table 1 and Fig.5. 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. While minimum keeping quality was observed with T_{24} (5.90 days).

The data presented in Table 1 and Fig. 6 clearly indicate that the significantly highest oil percentage of flower (0.44%) was reported with T_{22} 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).

The combined application of bio-fertilizers and organic manures significantly increased ratio of disk and ray florets (4.04) under treatment T_{26}, followed by treatment T_{34} (3.92), T_{22} (3.89) and T_{25} (3.61). While minimum ratio of disk and ray florets (1.51) was observed under control, which is presented in Table 1 and Fig. 7.

Thus, the results have proved that application of T_{22} ($A_2 P_1 V_1$) is most effective (1:4.10) in enhancing C.B. ratio of African marigold (*Tagetes erecta* L.) followed by 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 and Fig. 8. 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.

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