Annals of Plant and Soil Research 20 (Supplement) pp S73 – S77 (2018)

Effect of graded levels of nutrients and Biofertlizers on African marigold (*Tagetes erecta L.*)

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ABSTRACT

A field experiment was conducted at research farm of R. B. S. College, Bichpuri, Agra to study the effect of graded levels of nutrients and biofertizers on growth and yields of African marigold (Tageteserecta. L). Sixteen treatments were evaluated in randomized block design with three replications.The results revealed that the application of 150 kg N, 60kg P_2O_3 and 80kg K_2O along with 10 kg VAM and 2 kg Azospirillum ha^{-1} was found most effective for promoting the flower growth and flower yield. The control treatment took more days for first flower bud and first flower initiation than those of other treatments. But the minimum value of other flower growth parameters and flower yield were recorded under control.

Key words: Nutrients, biofertilizers, flower yield, African marigold

INTRODUCTION

Marigold is an economically important loose –flower crop. The conventional nutrient (NPK) applications to crops, in general are creating threat to the soil health. Therefore, the NPK integration with bio-fertilizers could be safer and economic choice.The bio-fertilizers are inputs containing micro organisms which are capable of mobilizing nutritive elements from non-usable form to usable form through biological processes. These are relatively less expensive, more eco-friendly and sustainable and they do not require non renewable source of energy during their production. Moreover, they improve plant growth and quality of crops by producing plant hormones, besides increasing the sustainability of soil and thereby making it more productive. With this idea, an investigation with the integration of NPK VAM and *Azospirillum* was carried out on African marigold variety (PusaNarangi).

MATERIALS AND METHOD

The experiment was conducted at the agricultural farm, R.B.S. College, Bichupri, Agra. The experimental soil has pH 7.7, organic carbon 3.8 g kg^{-1}, available N 170 kg ha^{-1}, P14.4 kg ha^{-1} and K180 kg ha^{-1}. The treatments under comparison were T_1 control, T_2 (full dose of NPK i.e. 200, 80 and 80 kgha^{-1}, respective!y), T_3 3/4th of NP and full K), T_4 (half NPand full K), T_5 (VAM 10 kg ha^{-1}), T_6 (Azospirillum 2 kg ha^{-1}), T_7 (Full NPK + VAM), T_8 (3/4THNP and full K + VAM), T_9 (Half NP and full K + VAM), T_{10} (Full NPK + Azospirillum), T_{11} (3/4thNP and full K + Azospirillum), T_{12} (Half NP and full K + Azospirillum), T_{13} (VAM + Azospirillum), T_{14} (Full NPK + VAM + Azospirillum), T_{15} (3/4th NP and full K + VAM + Azospirillum) and T_{16} (Half NP and full K + VAM + Azospirillum). VAM with FYM in 1:12.53 ratio was applied at the time of transplanting@ 2 g of mixture per planting hole, whereas Azospirillum was added with FYM in 1:62.5 ratio. The experiment was carried out in the randomized block design with three replications. FYM was applied @ 25ton ha^{-1} as basal dose with all the treatments except T_1 Control. Half dose of nitrogen, full dose of $P_2O_5$and K_2O were applied as basal dose as per treatment, whichever required while remaining half dose of N was applied as topdressing45days after transplanting. The seedlings of 4 week old were transplanted in the month of October. The plant growth parameters were recorded in the middle of March at the full bloom stage.

RESULTS AND DISCUSSION

Various phases of flowering exhibited pronounced implications of treatments relating to macro-nutrients in collaboration with bio-fertilizers, (VAM and *Azospirillum*). The data (Table 1) have clearly shown that flowering was significantly accelerated by the nutrients (NPK) and bio-fertilizers applied to marigold crop. The flower buds started to appear on the plants earliest after transplanting with the application

T_{15} (150 kg N, 60 kg P, 80 kg K, 10 kg VAM and 2 kg *Azospirillum*ha^{-1}. Moreover, the marigold plants flowered earliest with T_{15} followed by T_{14} full N, P and K + VAM + *Azospirillum*. It is, thus, obvious that integrated application of nutrients along with VAM and *Azospirillum* accelerated flowering on ornamental plants like those on marigold. Treatment. T_{15} brought about 2.06% acceleration in the appearance of the flower buds with simultaneous acceleration in flowering by 36.29%, in comparison to control (T_1). Acceleration in both the flowering phases caused by T_{15} and T_{14} were on the par in their effects on appearance and development of flower-buds to blooming stage.

Table 1: Effect of graded level nutrients and biofertizerson African marigold

Treatments	Days to first flower bud	Days to first flower	Periodicity of flowering (days)	No. of floral heads per plant	No. of floral buds on the plant	Largest Flower size on first harvest (cm)	Size of largest floral heads at last harvest (cm)	Weight of floral heads per plant (g)	Weight of per flower (g)	Yield of flower head (q ha^{-1})
T_1	70.1	87.6	15.1	23.4	8.6	4.91	4.17	193.2	7.56	35.22
T_2	48.4	71.0	22.0	47.3	20.4	6.68	5.89	466.4	9.97	162.54
T_3	53.3	74.8	19.8	39.0	15.5	6.36	5.34	367.1	9.48	117.42
T_4	57.7	78.1	18.5	32.6	12.3	5.82	4.94	344.7	9.02	86.47
T_5	59.4	81.7	17.5	29.4	10.9	5.22	4.66	314.4	8.91	83.68
T_6	64.3	82.6	17.3	27.7	10.1	5.22	4.65	270.6	8.72	72.56
T_7	46.6	64.4	22.5	53.1	23.3	7.11	6.14	524.0	10.72	225.99
T_8	49.1	73.0	21.6	44.7	19.7	6.62	5.81	441.1	9.81	159.78
T_9	54.5	76.3	20.7	40.9	16.8	6.44	5.56	394.9	9.59	121.95
T_{10}	46.8	66.2	22.2	51.9	22.4	6.84	6.11	499.5	10.59	194.68
T_{11}	51.6	73.7	21.5	42.9	18.1	6.48	5.61	412.7	9.74	149.61
T_{12}	56.5	76.4	19.5	35.6	14.8	6.33	5.34	359.3	9.37	115.12
T_{13}	57.8	80.0	19.4	32.9	13.6	6.22	5.18	345.8	9.14	110.61
T_{14}	45.1	59.5	22.5	58.4	24.4	7.14	6.41	571.5	11.21	245.83
T_{15}	41.8	57.5	24.0	64.3	28.5	7.25	6.62	592.4	11.74	259.38
T_{16}	48.1	69.0	22.1	50.3	20.7	6.76	6.05	483.5	10.34	178.04

Besides above, T_{15} interestingly prolonged the periodicity of flowering (days). This period was distinctly marked and the longest (24.00 days) with T_{15} as against the shortest (15.11 days) with control (Table 1). However, T_{14} was statistically as good as T_{15} (periodicity). Prolonged periodicity in flowering was, thus, a characteristic feature of integrated application of inorganic and bio-fertilizers. It appears that application of various nutrients through T_{15} and T_{14} induced early flowering due to profound synthesis of proteins and carbohydrates causing there by early development of floral primordia on the mother plants. De and Dhiman (2001) pointed out the advanced spike emergence (65.50 days) with the treatment comprising N : P : K doses at the rate of 200 : 200 : 200 kg ha^{-1}. Increase in the periodicity of flowering under VAM and *Azospirillum* treatments particularly the treatments involving both VAM and *Azospirillum* might be explained in the light of the fact that these treatments resulted in considerably more plant height and number of branches, thus, increasing the leaf area for photo-synthesis. Yield of flowers exhibited beneficial changes due to application of T_2 to T_{16} treatments over control (T_1). However, the extent of increase in flower yield varied from treatment-to- treatment. Among T_2 to T_{16} treatments, T_{14} and T_{15} exhibited parity between themselves empowered with statistical superiority over rest of other treatments including T_1, T_{15} augmented the flower yield by 348.19% over control (T_1) while the contribution of increase in flower yield of T_{14} over T_1 was 316.18%. Thus, there was more than threefold increase in the yield of flowers of marigold with the application of T_{15} (3/4th N, P and full K + VAM + *Azospirillum*) and T_{14} (Full N, P and K + VAM + *Azospirillum*) in comparison to control (Table 2). Such a commendable improvement in flower yield is, therefore, a matter of concern, and it requires critical examination at the moment.

Table 2: Effect of graded nutrient level on African marigold (*Tagetes erecta* L.) in relation to VAM and Azospirillum

Treatments	Days to first flower bud (days)		Days to first flower (days)		Periodicity of flowering (days)		Number of floral heads per plant		Number of floral buds on the plant		Largest Flower size on first harvest (cm)		Size of the largest floral heads at the last harvest (cm)		Weight of floral heads per plant (g)		Weight of per flower (g)		Yield of flower heads (q ha^{-1})	
Year	2002 - 03	2003 - 04	2002 - 03	2003 - 04	2002 - 03	2003 - 04	2002 - 03	2003 - 04	2002 - 03	2003 - 04	2002 - 03	2003 - 04	2002 - 03	2003 - 04	2002 - 03	2003 - 04	2002 - 03	2003 - 04	2002 - 03	2003 - 04
T_1	70.11	60.11	87.67	80.11	15.11	15.33	23.45	24.11	8.60	10.00	4.91	5.35	4.17	4.79	193.24	255.46	7.56	7.64	35.22	99.76
T_2	48.44	40.11	71.00	62.78	22.00	21.78	47.33	51.48	20.47	22.43	6.68	7.03	5.89	6.28	466.44	475.07	9.97	9.77	162.54	250.65
T_3	53.33	45.00	74.89	66.44	19.89	19.66	39.07	41.84	15.53	17.67	6.36	6.61	5.34	5.90	367.17	372.35	9.48	9.27	117.42	198.16
T_4	57.76	49.11	78.11	69.78	18.56	18.89	32.69	34.03	12.33	14.40	5.82	6.31	4.94	5.33	344.76	349.70	9.02	8.84	86.47	185.90
T_5	59.44	51.11	81.78	73.56	17.56	16.89	29.44	31.37	10.97	12.80	5.22	6.14	4.66	5.16	314.41	320.35	8.91	8.69	83.68	156.37
T_6	64.33	54.78	82.67	74.55	17.33	16.44	27.78	29.83	10.17	11.63	5.22	6.08	4.65	5.12	270.61	275.80	8.72	8.63	72.56	103.55
T_7	46.67	37.78	64.45	56.33	22.56	22.56	53.14	55.83	23.37	25.73	7.11	7.42	6.14	6.72	524.07	530.49	10.72	10.55	225.99	302.29
T_8	49.11	40.78	73.00	64.67	21.67	21.55	44.75	47.25	19.70	21.67	6.62	6.98	5.81	6.27	441.11	446.97	9.81	9.68	159.78	242.10
T_9	54.56	46.33	76.33	67.45	20.78	19.89	40.99	42.84	16.80	18.83	6.44	6.78	5.56	5.99	394.97	395.38	9.59	9.32	121.95	201.80
T_{10}	46.89	38.56	66.22	57.33	22.22	22.22	51.90	54.44	22.40	24.47	6.84	7.35	6.11	6.66	499.53	506.18	10.59	10.29	194.68	274.19
T_{11}	51.67	43.33	73.78	65.45	21.56	20.78	42.93	45.56	18.13	20.27	6.48	6.87	5.61	6.15	412.76	422.03	9.74	9.42	149.61	222.57
T_{12}	56.56	48.22	76.45	68.00	19.55	19.56	35.60	37.57	14.80	16.83	6.33	6.51	5.34	5.80	359.32	365.47	9.37	9.20	115.12	197.96
T_{13}	57.89	49.56	80.00	71.56	19.45	19.00	32.92	35.71	13.67	15.73	6.22	6.44	5.18	5.63	345.88	351.40	9.14	8.88	110.61	187.42
T_{14}	45.11	36.89	59.56	51.33	22.56	22.67	58.40	61.14	24.40	28.10	7.14	7.55	6.41	6.94	571.51	584.89	11.21	10.82	245.83	315.94
T_{15}	41.89	33.56	57.56	49.33	24.00	24.00	64.30	67.22	28.53	32.67	7.25	7.95	6.62	7.17	592.49	603.08	11.74	11.50	259.38	345.61
T_{16}	48.11	38.33	69.00	60.78	22.11	22.11	50.32	52.88	20.73	23.80	6.76	7.29	6.05	6.50	483.50	492.89	10.34	10.02	178.04	260.09

The crop yield is the outcome of joint effect of plant population per unit area of land and performance of individual plant. The crop population was at par regardless of treatments from T_1 to T_{16}. The mortality of crop plant was negligible in all treatments due to timely gap filling, wherever necessary. Therefore the crop-stand was more or less per cent in each plot during both the years. Obviously under such conditions, the productivity of individual plant is the only other attribute responsible for treatment effects on flower yield per unit area of land. The weight of flowers per plant revealed pronounced impact of fertility treatments from T_2 to T_{16}as high as 592.49 g flowers per plant were produced at T_{15} as against 193.24 g per plant with control (T_1). However, this weight of flowers per plant (with T_{15}) was closely followed by 571.5 g the flower weight with T_{14} during both the years successively. The statistical comparison of T_{15} and T_{14} exhibited parity between both the treatments which further expressed economic superiority of T_{15} over T_{14} with regard to per plant weight of loose flowers of African marigold. The weight of flowers per plant, in the combined outcome of number of flowers per plant and weight per flower (Table-1)**.** The study of data portrayed in tables under reference further infers superiority of T_{14} and T_{15} over other treatments including T_1 (control). The flower number was the lowest in order of merit in comparison to other treatments of NPK with or without VAM and/or *Azospirillum*. On contrary, T_{15} ranked the highest both in the number of flowers per plant and average weight per flower head (g).Treatment, T_{15} was credited with 176.53% superiority over control while the margin of improvement in this parameter caused by T_{14} over T_1 was 151.34%. Maximum flower productivity of loose flowers of marigolds attributed by T_{15} (3/4th N, P and full K + VAM + *Azospirillum*) is logically justified with the contributory factors explained and elucidated here above. Increase in the number of flowers and yield per plant under T_{14} and T_{15} particularly the treatments involving both VAM and *Azospirillum* might be explained in the light of the fact that these treatments resulted in considerable higher plant height and number of branches, thus, increasing the number of flowers and yield. The basic principle is that VAM enhances the absorption of immobile plant nutrients responsible for vigorous vegetative growth as reported by Yadav and Singh (1999).

The size of flower head exhibited striking improvement by T_{15} and T_{14} over T_1 (Table 2). However, the minimum flower size was observed under control. All the treatments in this investigation involving both VAM and *Azospirillum* in combination with various levels of N, P, and K were considerably more effective than other treatments due to enhanced absorption in the bio-fertilizer-inoculated- plants, thus leading to increased availability of N, P and K for accelerated plant growth and development. Banker and Mukhopadhyay (1990) in tuberose. Increased periodicity of flowering also attributes the flower yield as noted with T_{15} in this investigation and this may be a reason for greater quantum of flowers with this treatment. The encouraging effect of nitrogen on plant growth can be explained by the fact that nitrogen is most important constituent of chlorophyll, protein and amino acids as stated by Bankar and Mukhopadhyay (1990). The superiority of floral studied may be correlated with the effectiveness of nutrient- management-treatments on vegetative growth of marigold which was largely responsible for source and sink relationship in the light of photosynthetic activity of leaves. In partial support of these findings Agrawal *et al.* (2002) reported that application of 300 kg N, 200 kg P_2O_5 and 200 kg K_2O per hectare increased the number of flowers per plant and diameter of flower in African marigold. Chandra *et al.* (2000) recorded the interaction of N, P and K at higher dose of these elements (i.e. N_{45}, P_{30}, K_{30} g/m^2) showed the maximum spike length, number of florets per spike, diameter of the flower and yield of spike in gladiolus. Singh *et al.* (2002) recommended 120 kg N, 60 kg P_2O_5, 40 kg K_2O and 10 toness FYM ha^{-1}, 25 lg $ZnSO_4$ ha^{-1} and use of bio-fertilizer of following INM package in crop husbandry of tuberose.

For increasing flower size and yield of marigold, the treatment $T_2$to T_{16} indiscriminately proved effective over control. It was further noted that the magnitude of flower size and flower yield increase was more marked with the treatments involving either VAM or *Azospirillum*, or both in addition to full or 75% doses of NPK.

REFERENCES

Agrawal, S.I.; Agrawal, N.; Dixit, A. and Yadav, R.N. (2002) Effect of N and K_20 on African marigold in Chaittisgarhregion. *Journal of Ornamental Horticulture* (New Series) **5** (1): 86.

Chandra, S.; Barma, G. and Roychowdhury (2000) Influence of different levels of nitrogen, phosphorus and potassium on growth and flowering of gladiolus. *The Horticulture Journal* **13** (1): 79-86.

De, L.C. and Dhiman, K.R. (2001) Effect of leaf manures potassium and GA_3 on growth flowering and longevity of tuberose. *Journal of Ornamental Horticultural.*NewSereis **4** (1) : 50-52.

Gowda, J.V.N.; Jyothi, R. and Raju (1987) Studies on effect of nitrogen and phosphorus on flowering in gladiolus cv. Debonair. *Current Research* **14**: 80-81

Gupta, N.S.; Sadavarte, K.T.; Mahorkar, K.K.; Jadnao, B.J. and Dorak, S.V. (1999).Effect of marigold (*Tageteserecta* L.). *Journal of soils and crops.***9** (1): 80-83.

Singh, G. (2002) A study on integrated nutrient management (INM) in tuberose *(Polianthes tuberose* L.). Ph.D. Thesis Dr. B.R. Ambedkar University, Agra (U.P.).

Sreenivas, K.N. and Gowda, J.V.N. (1999) Effect of different organic manures on growth and flower yield of China aster *(Callistephuschinensis* Nees.). Crop Research, Hissar.**18** (1): 104-107.

Yadav, P.K., Singh, Sukhbir, Dahia, S.S. and Singh, S. (1999) Effect of N and FYM on chlorophyll and nutrient content in leaf of African marigold at flower and initiation stage. *Environment and Ecology* **17** (1): 188-190.