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Research Article

EFFICACY OF AZOTOBACTER AND PHOSPHATE SOLUBILIZING BACTERIA ON VEGETATIVE AND FLORAL ATTRIBUTES OF AFRICAN MARIGOLD (*Tagetes erecta* L.) *CV.* PUSA NARANGI GAINDA UNDER HILLY REGIONS OF UTTARAKHAND

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Abstract- The present investigation was conducted to study the efficacy of *Azotobacter* and Phosphate Solubilizing Bacteria on Vegetative and Floral attributes of African marigold (*Tagetes erecta* L.) *cv.* Pusa Narangi Gainda under hilly regions of Uttarakhand at College of Horticulture, VCSG UUHF, Bharsar, Pauri Garhwal, Uttarakhand during February to July 2017. The results revealed that application of *Azotobacter* + PSB + RDF (T_8) significantly recorded maximum vegetative attributes like plant spread (63.12 cm), number of primary branches per plant (15.70), number of secondary branches per plant (28.13), number of leaves per plant (442.00) and fresh weight of 30 leaves (33.33g). Floral attributes *viz.,* number of days taken for first flower bud initiation (50.13), number of days taken for first flower opening (68.52), number of days taken for 50% flowering (78.39), flowering duration, (70.89), flower diameter (9.30cm), number of flowers per plant (52.39) and number of flowers per plot (628.72)and quality attributes *viz.* shelf life (7.73 days),whereas, plants treated with plots *Azotobacter*+ RDF (T_4) showed maximum plant height (94.97 cm), dry weight of 30 leaves (6.07± 0.89) and flower weight (14.10 ±1.25).

Keywords- Pusa Narangi Gainda, Marigold, *Azotobacter*, PSB, RDF, Organic manures, Vegetative attributes and Floral attributes.

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Introduction

Marigold is apopular flower crop of Uttarakhand and holds a special place among other flowers on account of its ease to cultivation, wide adaptability and long flowering habit. It belongs to the genus *Tagetes,* family Asteraceae, and is a native to Mexico. It is highly suitable as a loose flower, pot plant, bedding plant and many more. They are grown not only for its ornamental use but also grown commercially for extraction of carotene pigments mainly xanthophylls which is added to poultry feed for intensification of yellow colour egg yolk [1,2]. The various factors which are responsible for the successful commercial cultivation of marigold are prevailing climatic conditions of an area, soil type, irrigation, nutritional factors, season of growing, plant density per unit area, *etc.* Out of these factors, nutrition plays a pivotal role in growth, yield and quality of flowers. To reap maximum profit from its cultivation increased flower production, quality of flowers and perfection in the form of plants are the important objectives to be kept in consideration. Though the use of nitrogen, phosphorous and potassium influence the production and quality of flowers greatly, but for maintaining the sustainability, it is important to incorporate bio organisms & organic matter in the soil. Bio-fertilizers also known as 'microbial inoculants' are an important component that can be added to maintain sustainability as these may be biological nitrogen fixers, P-solubilizing, mineralization of nitrogen and transformation of several elements like sulphur and iron into available forms. The biofertilizers can save 25 to 35 per cent of the requirement of inorganic nitrogen per hectare [3]. It has reported that flower yield can be increased up to 40% with the use of biofertilizers as a supplement [4sriv]. *Azotobacter* is one of the most important non-symbiotic nitrogen fixing micro-organisms. Several phosphate solubilizing bacteria particularly those belonging to genera *Pseudomonas* and *Bacillus* posses the ability to bring insoluble phosphate in soil into soluble form by secreting organic acids which lower the pH and bring about dissolution of bound phosphate. By using organic manure like Farmyard manure improves the fertility status of the soil. Thus, this experiment was planned and conducted to assess the importance of biofertilizers along with the use of inorganics and organics in the cultivation of Marigold *var.* Pusa Narangi Gainda so that the farmers of this region can reap maximum profit from its cultivation.

Materials and Methods

A field trial was carried out under open conditions at College of Horticulture, VCSG, Uttarakhand University of Horticulture and Forestry during the month of February to July 2017. The experiment was laid out in randomized complete block design and was replicated thrice. This experiment consisted of recommended dose of fertilizers (150:150:100 N P K kg/ha) of marigold, biofertilizers *[Azotobacter* (30ml/15Lof water) and PSB (50ml/15L of water)] and Farmyard Manure (30t/ha). Bio-fertilizers were applied as seedling dip method, whereas, organic and inorganic sources were incorporated directly into the soil. Experiment included nine treatments *viz.,* Control (T_1), RDF (T_2), FYM (T_3), *Azotobacter* + RDF (T_4), PSB + RDF (T_5), *Azotobacter* + FYM (T_6), PSB + FYM (T_7), *Azotobacter* + PSB + RDF (T_8), *Azotobacter* + PSB + FYM (T_9). The seedlings of were transplanted after 40 days in the respective plots at the spacing of 40 cm X 30 cm. All the standard cultural practices were followed uniformly. All the vegetative and floral attributes were recorded and analysed statistically as per the methods by

Gomez and Gomez [5].

Results and Discussion

The data recorded was statistically analysed and it is pertinent from the [Tables-1& 2] that there was a significant effect of the combinations used during the field trial.

From the data presented in [Table-1], it is evident that the plant height varied significantly with respect to different treatments used. Maximum plant height (94.97 ± 0.55) was attained in the treatment (T_4) containing *Azotobacter* + RDF which was significantly higher to other treatments. Treatments T_8 (*Azotobacter* + PSB + RDF) and T_9 (*Azotobacter* + PSB + FYM) were found statistically at par with each other, *i.e.,* 91.58 ± 0.61&91.03 ± 0.75 respectively. However minimum plant height (76.03 ± 0.87) was observed from plants grown in control. The enhanced plant height may be due to the presence of more readily available form of nitrogen due to the use of Azotobacter, which might have triggered the vegetative growth of plant. Nitrogen which is a main constituent of chlorophyll, protein and amino acids, plays an important role in cell division, protein synthesis and metabolite transport which further help to build the plant tissues [6]. This is in line with the findings of Kumar *et al*. [7 2013] in marigold (*Tageteserecta* L.) *cv.* Pusa Basanti Gainda.

Plant spread determines the size of the plants in different directions. A well spread plant will look pleasing and artistic as well as produces good number of showy flowers. Perusal of the data pertaining to the effect of *Azotobacter* and Phosphate solubilizing bacteria on plant spread clearly indicates the remarkable effect of various treatments on African marigold depicted in [Table-1]. Maximum plant spread (63.12 ± 0.48) was observed from the plants grown in the plots applied with treatment containing *Azotobacter* + PSB + RDF (T_8) which was significantly higher over other treatments but was statistically at par with T_4 containing *Azotobacter* + RDF(61.34 ± 0.90). Treatments T_2 (RDF) and T_9 (*Azotobacter* + PSB + FYM) were found to be statistically at par with each other *i.e.,* 60.59 ± 0.95 & 60.05 ± 0.92. Minimum plant spread (48.31 ± 0.41) were recorded in the plants that were not supplied with any media *i.e.* T_1 control. All the treatments were found to be statistically significant over control i.e., T_1.Thisincrease in the plant spread might be due to the use of combination of RDF with *Azotobactor* which gave an additive effect and due to secretion of certain growth promoting substances like auxin, gibberellins, vitamins, and organic acids in soil with bio inoculation. Asokan*et al.* [8] also reported that phosphate solubilizing bacteria secretes some organic acids such as lactic, glycolic, fumaric & succinic acids which convert insoluble phosphates into soluble forms. Above findings are in corroboration with Bhatt *et al* [9] who reported more number of primary branches with the application of *Azotobacter*+ PSB + 3/4th dose of N + full dose of P_2O_5.

Table-1 *Effect of Azotobacter and Phosphate Solubilizing Bacteriaon the vegetative characters of African marigold (TageteserectaL.) cv. PusaNarangiGainda*

Treatments		Plant height (cm) ± S.E(m)	Plant spread (cm) ± S.E(m)	Number of primary branches per plant ± S.E(m)	Number of secondary branches per plant ± S.E(m)	Number of leaves per plant ± S.E(m)	Leaf area (cm^2) ± S.E(m)	Fresh weight of 30 leaves (g) ± S.E(m)	Dry weight of 30 leaves (g) ± S.E(m)
T_1	Control	76.03 ± 0.87	48.31 ±0.41	10.78 ± 0.11	191.00 ± 2.65	31.21 ± 1.38	18.33 ± 0.88	4.26 ± 0.59	13.77 ± 0.29
T_2	RDF	87.61*± 0.69	60.59*±0.95	13.93* ±0.15	370.11* ±1.83	35.72 ± 1.81	19.67 ± 0.88	4.45 ± 0.51	24.10* ± 2.11
T_3	FYM	85.90*± 1.18	57.93*±0.97	13.49*± 0.86	257.92*± 8.76	35.91 ± 0.41	24.00 ± 2.31	5.23 ± 0.51	14.47 ± 0.62
T_4	*Azotobacter* + RDF	94.97*± 0.55	61.34*±0.90	15.17*± 0.18	342.03*± 3.61	41.08 ± 1.26	27.67*±1.86	6.07* ± 0.89	26.67*± 0.20
T_5	PSB + RDF	83.45*± 0.50	57.09*±0.34	12.35*± 0.33	305.11* ±7.68	37.65 ± 6.54	21.33 ± 2.19	4.59 ± 0.40	21.57*± 0.30
T_6	*Azotobacter* + FYM	82.48*± 0.94	56.38*±0.87	11.76 ± 0.57	280.73*± 2.85	44.71 ± 4.82	23.67 ± 0.88	5.18 ± 0.32	16.90 ± 0.59
T_7	PSB + FYM	84.64*± 0.66	55.03*±0.13	12.48*± 0.58	300.36* ±3.01	41.94 ± 1.74	22.67 ± 4.37	5.17±0.84	21.23*± 0.47
T_8	*Azotobacter* + PSB + RDF	91.58*± 0.61	63.12*±0.48	15.70*± 0.55	442.00*± 6.04	39.17 ± 2.49	33.33*±1.76	5.52 ± 0.37	28.13*± 1.72
T_9	*Azotobacter* + PSB + FYM	91.03*± 0.75	60.05*±0.92	14.90*± 0.46	328.07*±1.40	35.42 ± 0.80	23.00 ± 3.22	5.19 ± 0.30	23.33*± 0.52
S.E(d)		1.01	1.03	0.67	1.47	6.61	4.06	3.37	0.84
$C.D_{(0.05)}$		2.15	2.21	1.44	3.13	14.14	8.60	7.20	1.78

*Significant at 5% level of significance with control

Branches are the skeletal structure of the plant and were found to be significantly influenced by the use of different sources of nutrients applied during the course of investigation. Maximum number of primary branches (15.70 ± 0.55) and secondary branches per plant (28.13 ± 1.72) was produced from treatment T_8containing *Azotobacter* + PSB + RDF. Number of primary branches were found to be statistically at par with T_4*Azotobacter* + RDF (15.17 ± 0.18) and T_9 *Azotobacter* + PSB + FYM (14.90 ± 0.46), whereas, number of secondary branches were statistically at par with treatment T_4 (*Azotobacter* + RDF) (26.67 ± 0.20). However, minimum number of primary branches per plants (10.78 ± 0.11) and secondary branches per plant (13.77 ± 0.29) were recorded from the plants that were applied with no treatment combination control *i.e.*,T_1. Increase in the branches applied with *Azotobacter,* PSB and RDF might be due to the better flow of macro and micro nutrients along with plant growth substances into the plant system, where it might have favoured the production & stimulation of auxillary buds which further have resulted in formation of more number of primary and secondary branches. Similar findings were also reported by Chougala [10] in Double Daisy, Nethra [11]in China-Aster and Kumawat *et al* [12]. in African marigold

Leaves are the photosynthetic part of plant and the yield of crop is directly correlated to the number of leaves. It is clearly indicated in [Table-1] that there is wide range of variation for the number of leaves they ranged from 191.00 to 442.00. Maximum numbers of leaves (442.00 ± 6.04) were produced in the treatment T_8 which is a combination of *Azotobacter* + PSB + RDF and was significantly higher over all other treatments, whereas, minimum number of leaves (191.00 ± 2.65) was recorded from treatment T_1 i.e., control. All the treatment combination was found to be significantly superior over control (T_1). This increase in number of leaves might be due to increased nitrogen, phosphorous and potassium availability which can be directly supplied by RDF. The use of bio-fertilizers also led to better availability of nitrogen and phosphorous that can also be a reason for better root proliferation, uptake of nutrients and water, thus causing more leaf growth. All these factors ultimately contribute to cell multiplication, cell enlargement and differentiation which could have resulted in better photosynthesis and ultimately exhibited more number of leaves.

Fresh weight and dry weight of leaves was greatly influenced by the different treatments allotted to the plots. Statistical analysis of data for fresh weight of 30 leaves is presented in [Table-1] and indicates that among the different treatments applied the maximum fresh weight of 30 leaves (33.33 ± 1.76) was observed from the treatment T_8 containing *Azotobacter* + PSB + RDF and was statistically at par with T_4 (*Azotobacter* + RDF)(27.67 ± 1.86) ,whereas, minimum fresh weight of 30 leaves (18.33 ± 0.88) were obtained from the plants grown in control i.e.,T_1 and was statistically at par with all other treatments except T_4 and T_8.A critical glance over the data presented in [Table-1] revealed that dry weight of 30 leaves exhibited significant differences among the different treatment applied. Maximum dry weight of 30 leaves (6.07 ± 0.89) were obtained from the plants treated with combination *Azotobacter* + RDF *i.e.,* T_4 and minimum dry weight of 30 leaves (4.26 ± 0.59) was observed from the plants grown in control, i.e., T_1.The increase in fresh and dry weight of leaves may be attributed to the increase in the nitrogen level in plant due to *Azotobacter* and increased availability of phosphate ions.

These findings are in corroboration with the work of Syamal *et al.* [13] and Dhami *et al.* [14] in African marigold (*Tagetes erecta* L.) *cv.* PusaNarangiGainda.

The perusal of data presented in [Table-2] revealed that treatment T_8 which is a combination of *Azotobacter* + PSB + RDF produced the earliest flower bud initiation (50.13± 1.02) and was found to be statistically at par with T_9 (52.33 ± 1.37) and T_2 (53.67± 1.18), whereas, maximum (61.83± 0.88) days taken to flower bud initiation was observed from the plants grown in control i.e., T_1. It is clear from the data all the treatments were found significantly superior over control (T_1).

Number of days taken for of first flower opening was significantly influenced by different treatments used. From the data presented in [Table-2] was found that the treatment combination *Azotobacter* + PSB + RDF (T_8) took minimum (68.52 ± 0.48) days for opening of first flower and was found statistically at par with T_9 (69.51 ± 0.34)and T_4 (69.91 ± 0.77). Maximum (77.19 ± 0.51) number of days taken for opening of first flower was recorded in control (T_1). All the treatments were found to be superior over control (T_1).

The data pertinent to days required for 50% flowering have been recorded and on the basis of data presented in [Table-2], the different treatment combinations under study showed significant differences among themselves. The least number of days (78.39 ± 0.53) taken for 50% flowering was observed in treatment T_8 which is combination of *Azotobacter* + PSB + RDF followed by T_9 (81.60 ± 0.43). Whereas, maximum number of days (85.40 ± 0.40) taken for 50% flowering was observed from plots control i.e., T_1. All the treatments were found to be superior over control (T_1).

Table-2 *Effect of Azotobacter and Phosphate Solubilizing Bacteria on Flowering and yield parameters*

Treatments		Number of days taken for first flower bud initiation ± S.E(m)	Number of days taken for first flower opening ± S.E(m)	Number of days taken for 50% flowering ± S.E(m)	Flowering duration (days) ± S.E(m)	Flower diameter (cm) ± S.E(m)	Fresh weight of flower (g) ± S.E(m)	Number of flowers per plant ± S.E(m)	Number of flowers per plot ± S.E(m)	Shelf life (days) ± S.E(m)
T_1	Control	61.83 ± 0.88	77.19 ± 0.51	85.40 ± 0.40	6.18 ± 0.19	7.30 ± 0.35	39.09 ± 0.90	469.04±10.80	4.78 ± 0.29	58.16±0.80
T_2	RDF	53.67*±1.18	71.08* ± 0.76	83.52* ± 0.52	7.32* ± 0.59	10.77*±1.52	48.24*±0.81	578.84*±9.72	6.96*± 0.16	66.90*±1.17
T_3	FYM	54.87*± 1.04	73.40*±0.39	85.14* ± 0.91	6.52 ± 0.42	8.02 ± 0.91	41.68*±0.47	500.12*±5.66	5.89 ± 0.40	63.51*±0.52
T_4	*Azotobacter* + RDF	55.60* ± 2.16	69.91*± 0.77	82.01*± 0.30	8.60* ±0.45	14.10*±1.25	50.19 *± 0.17	602.32*±2.00	7.67* ± 0.38	67.08*±0.73
T_5	PSB + RDF	54.73* ± 0.47	75.36* ± 0.70	82.40* ± 0.48	7.30* ± 0.44	9.82 ± 0.84	44.79 *± 1.27	537.52*±15.18	6.68* ± 0.58	64.48*±0.44
T_6	*Azotobacter* + FYM	55.67* ± 0.29	73.99*± 0.84	84.45* ± 0.39	7.88* ± 0.27	11.81*±0.30	43.84*± 0.83	526.12* ± 9.94	6.50* ± 0.48	62.28*±0.72
T_7	PSB + FYM	55.73* ± 1.13	74.26* ± 0.41	83.29* ± 0.73	7.25* ± 0.33	8.97 ± 0.94	45.69* ± 1.01	548.28*±12.10	6.55* ± 0.78	61.74*±0.67
T_8	*Azotobacter* + PSB + RDF	50.13*±1.02	68.52* ± 0.48	78.39*± 0.53	9.30*±0.10	13.79*±0.81	52.39* ± 0.57	628.72* ± 6.86	7.73* ± 0.47	70.89*±0.20
T_9	*Azotobacter* + PSB + FYM	52.33*± 1.37	69.51* ± 0.34	81.60* ± 0.43	8.53 *± 0.06	12.08*±0.38	47.29* ± 1.56	567.44*±18.68	6.33* ± 0.19	65.74*±0.47
S.E(d)		1.74	0.82	0.64	0.90	0.99	1.28	1.17	13.98	0.66
C.D $_{(0.05)}$		3.72	1.76	1.36	1.92	0.46	2.74	2.49	29.89	1.47

*Significant at 5% level of significance with control

The earliness in all these flowering parameters might be due to the effect of biofertilizers *viz., Azotobacter* & PSB, creating a conducive source sink relationship and ultimately causing an increase in the synthesis of cytokinin in the root tissue and its simultaneous transport to auxillary buds would have resulted in better sink for mobilization of photo assimilates at a rapid rate and have helped in the early transformation from vegetative to reproductive phase. Due to the application of bio-fertilizers there is acceleration in development of vegetative growth *viz.,* plant height, number of branches, increased plant spread which have further enabled the plants to produce more photosynthates and supply for the early floral primordial development. Similar results were observed by Parmar [13]in Gaillardia *cv.* 'Local', Naik and Dalawai[15] in Carnation, Ravindra *et al.* [16]in China aster, and Pooja *et al.* [17]in China aster *cv.* 'Kamini'.

Duration of flowering ranged from 58.16 days to 70.89 days with maximum duration of flowering (70.89 ± 0.20) in the treatment T_8 which is a combination of *Azotobacter* + PSB + RDF, whereas, minimum duration of flowering (58.16 ± 0.80) was observed from plots in control i.e., T_1. Data also revealed that all the treatments are significantly superior over control (T_1).

Data revealed that maximum flower diameter (9.30±0.10) was recorded from the plants grown in the plots receiving the treatment containing *Azotobacter* + PSB + RDF (T_8) followed by T_4 (8.60 ± 0.45), T_9 (8.53 ± 0.06). However, minimum (6.18 ± 0.19) flower diameter was recorded from control plot (T_1) and was statistically at par with T_3 (6.52 ± 0.42). All the treatment combinations were significantly superior over control T_1 except T_3.

Maximum fresh weight of flower (14.10 ± 1.25) was found from the flowers harvested from the plots receiving *Azotobacter* + RDF(T_4) and it was found statistically at par with T_8 (13.79± 0.81), T_9 (12.08 ± 0.38), T_6 (11.81 ± 0.30). Minimum flower diameter (6.18 ± 0.19) was recorded from plants receiving no treatment combination *i.e.*, T_1 (control). From the above data it is clear that all the treatments are significantly superior over control except T_3, T_5 and T_7. This increase in flower diameter and flower weight might be due to better nutrient uptake, higher photosynthesis, source– sink relationship & excellent physiological, biological activities due to presence of *Azotobacter* and PSB which have resulted in rapid synthesis and translocation of photosynthates from the source to developing flower bud and finally increase in flower diameter. The profound increase in flower weight due to nitrogen and phosphorus nutrients are due to the fact that nitrogen promotes protein synthesis, thus in turn promoting the development of floral primordial and phosphorus is involved in the formation of floral primordial. Their ample application resulted in increased weight of individual flower. Above results are also in line with the findings of Kumar *et al.*,[18]who reported increased flower diameter with application of 80% RDF + vermicompost + *Azotobacter* over control in marigold (*Tagetes erecta* L.) *cv.* PusaBasantiGainda. Mittal *et al.* [19] also reported increased flower weight with combined application of 70% RDF + 3 t/ha Vermicompost + *Azotobacter*+ *Azospirillum*+ PSB. Kumawat*et al.* [20] also reported increased flower with application of75% RDF + FYM @ 20 t ha-1+ azatobacter + PSB

Yield is an important parameter to decide the efficacy of a treatment. Data recorded on number of flowers per plant are depicted in [Table-2] revealed that the maximum number of flowers per plant (52.39 ± 0.57) was observed from the plants grown in the plots applied with *Azotobacter* + PSB + RDF (T_8) and it was found statistically at par with T_4 (50.19 ± 0.17). However minimum number of flowers per plant (39.09 ± 0.90) was recorded from the plants grown in control (T_1). All the treatments are significantly superior over control.

On perusal of data tabulated in [Table-2] it is evident that the highest number of flowers per plot (628.72 ± 6.86) was observed from the plants grown in the plots T_8 (*Azotobacter* + PSB + RDF) and it was found statistically at par with T_4 (602.32 ± 2.00). However, minimum number of flowers per plot (469.04 ± 10.80) was observed from the plants grown in control i.e., T_1. Data showed that all the treatments were found to be significantly superior over control (T_1). This increase in number of flowers might be due to the effect of bio-fertilizers along with the recommended dose of fertilizers. *Azotobacter*, which makes the unavailable nitrogen to available form to plants also enhances the uptake of Fe, Zn, Cu and Mo and helps in production of more number of flowers, whereas, Phosphate-Solubilizing Bacteria (PSB) species are also reported to beneficial in increasing the phosphorus availability in soil and thereby increasing yield. These are in line with the findings of [21]who found that highest yield of flower plant $^{-1}$ in calendula was noticed with the application of N (135 kg/ha) + P (90 kg/ha) + K (60 kg/ha) + *Azotobacter*(200kg/ha) along with VAM (15.6 g/plant).Similar results were reported by Singh *et al* [22] who found that more number of flowers plant^{-1} in marigold was

obtained with the application of 75 % recommended dose of NPK (75 Kg N, 75 Kg P_2O_5 and 75 Kg K_2O ha^{-1}) + vermicompost 80 q ha^{-1} + Azotobacter 3.3 Kg ha^{-1}.
Quality attributes *viz.,* shelf life was recorded to be significantly higher in T_8i.e7.73 days The increase in post harvest life of flower might be due to overall food nutrient status of flowers found under this treatment. It has been reported that application of *Azotobacter* will also help in synthesis of cytokinin, which decreases sensitivity of plant tissue to ethylene [23], and also the application of nitrogen hastens the senescence. These findings are in accordance with the findings of[24]&[25] in China Aster.
Thus it can be concluded from the findings that application of *Azotobacter* (@ 30ml/15l of water)+ PSB(50ml/15l of water) + RDF (150:150:100 Kg NPK/ha) and *Azotobacter* (@ 30ml/15l of water) + RDF (150:150:100 Kg NPK/ha) can be recommended for successful cultivation of African marigold (*Tagetes erecta* L.) *cv.* Pusa Narangi Gainda under hilly regions of Uttarakhand to get good returns.

Conclusion: The application of Azotobacter (@30ml/15l of water)+ PSB(50ml/15l of water) + RDF (150:150:100 Kg NPK/ha) and Azotobacter (@ 30ml/15l of water) + RDF (150:150:100 Kg NPK/ha) can be recommended for successful cultivation of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda under hilly regions of Uttarakhand to get good returns.

Application of research: Marigold is an important crop of Uttarakhand. The use of Azotobacter and PSB along with RDF can help to get handsome return to the farmers of hilly regions.

Research Category: Floriculture

Abbreviations:
PSB: phosphorus solubilizing bacteria
RDF: recommended dose fertilizer

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