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Beneficial microorganisms impacts rooting and the establishment of African marigold cuttings

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ABSTRACT

The investigation was done using bio-formulations containing beneficial microorganisms to assess the impact of beneficial microorganisms on the performance of African marigold cuttings during propagation and their establishment. Significant differences were observed for almost all parameters across different treatments. Observations have shown that the highest survival percentage (78.40%), number of branches per cutting (4.16), number of roots per cutting (34.46), the average length of roots per cutting (6.10 cm.), fresh weight of roots per cutting (0.25 g) and dry weight of root per cutting (0.11g) were recorded with the use of Trichoderma harzianum which gave the best results for all the parameters.

***Keywords*:** African marigold, beneficial microorganisms, cuttings.

INTRODUCTION

African marigold is a widely cultivated for its loose flower which isused in religious purposes and social gatherings. Marigold is one of the important commercial loose flower crops in India which ranks first in area and production among loose flowers (NHB, 2014-15). Karnataka, Tamil Nadu, Andhra Pradesh, West Bengal, and Maharashtra are significant marigold-producing states. They are rich sources of useful phytochemicals like terpenoids, flavonoids, carotenoids, and thiophenes. Marigold is the marketable source of lutein; petals of marigold are luxuriant in esters of lutein fatty acids and lutein, representing more than 90% of the pigments identified in Tagetes plant (Becerraa *et al*., 2020). Marigolds are typically multiplied by herbaceous tip cuttings and seeds. Propagation of African marigold *(Tegetes erecta* L.*)* through herbaceous tip cutting can give early flowering in addition to producing uniform and true to type plants. Beneficial microorganisms or plant growth promoting microorganisms (PGPMs) maintain key agroecological cycles fundamental for soil nutrient enrichment, crop nutrient improvement, plant tolerance to biotic and abiotic stresses, biocontrol of pests and diseases, and water uptake enhancement (Lobo *et al.*, 2019.The use of bio-formulations to boost crop output is currently given a lot of attention. The use of beneficial microbes in flower crops besides other horticultural crops, specially with respect to propagation and nursery raising is on the rise due to harmful effect of pesticides and chemical fertilizers on soil and environment. Considering the above points the investigation was carried out to study the impact of beneficial microorganisms on rooting and the establishment of African marigold cuttings.

MATERIALS AND METHODS

Experimental site

The experiment was conducted during 2021-2022 at the research cum instructional farm of School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema, which is located at $25^0$45’43’’N latitude and $93^0$53’04’’ E longitude at an elevation of 305 m above mean sea level. The climatic condition of the experimental site is typically a sub-humid tropical region with high humidity and moderate

temperature (12-32^{o}C), having high rainfall (2000-3000 mm) and RH of 70-80%. The mean temperature ranges from 21^{o} C to 32^{o} C during summer and rarely goes below 8^{o}C during winter. The average rainfall varies between 200-250 cm from April to September and from October to March it remains virtually dry.

Experimental details

The experiment was laid out in a randomized block design with seven treatments and three replications. Treatment consists of water soaking (Control), PSB (Phosphate Solubilizing Bacteria), Jeevamrutha, microbial consortia (*Psuedomonas taiwanensis, Bacillus aryabhatai, Azotobacter tropicalis*), IEM (Indigenous Effective Micro-organisms), *Pseudomonas fluorescence* and *Trichoderma harzianum.* There were ten number of cuttings per replication. Jeevamritha and IEM were prepared in the department, whereas other bioformulations were procured from University of Agricultural Sciences, GKVK, Bengaluru, India.

Preparation of Jeevamrutha

Jeevamrutha is organic liquid manure which was prepared using the following ingredient: 1kg of cow dung and 1litre of cow urine was mixed properly with the help of wooden stick in a plastic drum. To this mixture 200 g jaggery, 200 g gram flour and 100 g forest soil was added and kept for 7 days for fermentation. These mixtures were stirred for about every 6-8 hours for better microbial growth.

Preparation of IEM (Indigenous Effective Micro-organisms)

Indigenous effective micro-organism was prepared in 4 steps by following standard procedure which Japanese farmers followed. Firstly, cooked rice was taken in a bamboo container and kept under a bamboo groove and covered with leaf litter. After 4 days microbial growth on this rice media was collected and named as IMO-1. IMO-1 was mixed with equal part of jaggery and kept for 2-3 days for microbial growth, which named as IMO-2. Then IMO-3 was prepared by mixing of IMO-2 with 1 part of soil, 2 part of rice bran, 1 part of jaggery and 1 part of bean cake and kept in an air tight container to encourage anaerobic microbial growth for about a week. Lastly, IMO-4 was prepared using 50 mg IMO-3 which was diluted in 200 ml of water.

Preparation of beneficial microorganisms solution

A 2% solution was made by dissolving 20 g of PSB/ microbial consortium / *Pseudomonas fluorescence / Trichoderma harzianum* in 1 litre of water. For Jeevamrutha/ IEM, 20 ml was mixed with 980 ml of water for preparation of 2% solution.

Preparation of cuttings

Herbaceous tip cuttings were prepared from matured mother plant about 5 cm long, which had three to four buds.

Rooting of cuttings

Prior to planting, the cuttings were treated with the solution containing beneficial microorganisms for 60 minutes. Treated cuttings were planted in the sand with polythene bags and the medium around the cuttings was pressed firmly. In a single polythene bag, a single cutting was planted. For better rooting, polythene bags were kept in the polyhouse.

Observations and data analysis

The data recorded were tabulated and subjected to statistical analysis by following the standard ANOVA method with a 5% level of significance described by Gomez and Gomez (2012).

RESULTS AND DISCUSSION

Survival of cutting (%)

The data pertaining to survival percentage of cutting is presented in Table 1. The survival percentage was significantly influenced by the effect of different treatments. Survival percentage varied from 53.50% to 78.40%. Among the treatments, *Trichoderma harzianum* showed the best results (78.40%) for the final survival percentage followed by microbial consortia and *Pseudomonas fluorescence* which recorded a value of 76.40% and 70.40% respectively. Similarly, the minimum survival percentage (53.50%) was recorded in control. *Trichoderma* kills several major harmful root fungi like *Pythium, Rhizoctonia, Fusarium*, and results in healthy root development by decreasing the attack of soil-born pathogens (Woo *et al*., 2014), which in turn results in increased survival of the cuttings. The results are in agreement with the earlier findings of Patil *et al.* (2001) in pomegranate.

Table 1: Impact of beneficial microorganisms on survival percentage, number of branches and root per cutting

Treatments	Survival percentage (%)	Number of branches per cutting	Number of root per cutting
T_1	53.50	2.56	15.50
T_2	63.40	2.63	27.56
T_3	67.40	2.66	28.40
T_4	76.40	3.16	32.43
T_5	67.50	2.76	29.50
T_6	70.40	2.95	30.40
T_7	78.40	4.16	34.46
SEm (±)	**0.07**	**0.09**	**0.06**
CD (5%)	**0.22**	**0.29**	**0.20**

Table 2: Impact of beneficial microorganisms on the average length of roots, fresh weight and dry weight of roots per cutting

Treatments	Average length of roots per cutting (cm)	Fresh weight of roots per cutting (g)	Dry weight of roots per cutting (g)
T_1	3.20	0.16	0.06
T_2	3.50	0.17	0.09
T_3	3.50	0.17	0.10
T_4	5.50	0.19	0.10
T_5	4.10	0.18	0.10
T_6	4.50	0.24	0.10
T_7	6.10	0.25	0.11
SEm (±)	**0.03**	**0.06**	**0.06**
CD (5%)	**0.12**	**0.19**	**0.19**

Number of branches per cutting

A perusal of the data given in Table1 revealed that the number of branches per cutting was significantly influenced by the effect of treatments. Number of branches per cutting varied from 2.56 to 4.16. Among the treatments studied, *Trichoderma harzianum* showed the best results (4.16) in terms of the number of branches per cutting followed by microbial consortia which recorded the value (3.16). However, the minimum number of branches per cutting (2.56) was recorded with control. The increased number of branches might be due to plant growth regulators like IAA and cytokinins which were released by *T. harzianum* resulting in the breaking of apical dominance and accelerating production of higher number of branches. These results are in agreement with the reports of Karishma *et al*. (2011) in chrysanthemum, Sunitha and Hunje (2010) in African marigold and Harshavardhan *et al.* (2017) in carnation.

Number of roots per cutting

The results presented in Table 1 shown a significant effect of the treatments on the number of roots per cutting. The number of roots per cutting varied from 15.50 to 34.46. Among the treatments studied, *Trichoderma harzianum* recorded the maximum number of roots per cutting (34.46) followed by microbial consortia which recorded a value of 32.4. However, the minimum number of roots per cutting (15.50) was recorded with control. The increased number of roots might be due to the increased synthesis of growth promoting substances associated with treatment of *Trichoderma harzianum*.

Average length of roots per cutting

The length of root per cutting was significantly influenced by the effect of treatments as shown in Table 2. It varied from 3.20 cm to 6.10 cm. Among the treatments studied, *Trichoderma harzianum* recorded the maximum length of roots per cutting (6.10 cm.) followed by microbial consortia which recorded the value (3.10cm). However, the minimum length of roots per cutting (3.20cm) was recorded with control. The faster rate of cell division in the root tips brought on by the use of *T. harzianum* may be the cause of the increased root growth. These findings were also reported by Brandler *et al*. (2017) in gerbera, Nosir (2016) in tuberose, Bhargava *et al*. (2015) in antirrhinum. *Trichoderma* spp have the ability to increase soil and nutrient accessibility for the roots, increase the solubility of insoluble substances, and increase the availability of micronutrients, all while promoting growth and yield (Li *et al*., 2015).

Fresh weight of roots per cutting

The effect of treatments on the fresh weight of roots was statistically significant. The fresh weight of the root per cutting was significantly influenced by the effect of treatments. Fresh weight of the root per cutting varied from 0.16 g to 0.25 g. Among the treatments studied, treatment with *Trichoderma harzianum* showed the best results (0.25 g) and it was statistically superior to other treatments while the minimum fresh weight of roots per cutting (0.16g) was recorded with control.

Dry weight of roots per cutting (g)

It is clear from the data presented in Table 2 that the dry weight of root per cutting was significantly influenced by the effect of treatments. The dry weight of the root per cutting varied from 0.06 g to 0.11 g. Among the treatments studied, treatment with *Trichoderma harzianum* showed the best results (0.11 g) and it was statistically superior to other treatments. However, the minimum dry weight of roots per cutting (0.06 g) was recorded with control. Increased fresh root weight brought on by *Trichoderma harzianum* can be attributed to longer shoot lengths with longer internodes and a maximum number of foliage, which in turn are responsible for increased photosynthesis and its subsequent transfer to the root system. This mechanism of enhanced fresh weight may be due to the production of growth-regulating substances by *Trichoderma harzianum*.

CONCLUSION

Based on the above findings, it can be concluded that *Trichoderma harzianum* could be recommended for treating cuttings of African marigold for better rooting, establishment and production of more number of healthy seedlings as it showed best results across all metrics like survival percentage (%), number of branches per cutting, number of roots per cutting, average root length (cm), fresh weight of root per cutting (g), and dry weight of root per cutting (g).

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