Standardization of cost-effective nursery techniques in Marigold

ABSTRACT

An investigation entitled "Standardization of cost-effective nursery techniques in Marigold (*Tagetes sp*)" was conducted at Horticultural College and Research Institute, Coimbatore during the year 2020-2021. The experiment was conducted in Completely Randomized Design (CRD) with three replications and six treatments. Terminal cuttings of marigold was taken as the propagating material and it was raised in three types of containers viz., coco plugs, non-woven plug and protray filled with different combinations of media like cocopeat, vermicompost, VAM and *Bacillus subtilis*. Observations were recorded on survival percentage, vegetative parameters, branching and rooting parameters after 15th and 30th day of planting. Among all the treatments, the treatment T_2 (Non-woven plug + Cocopeat + Vermicompost + VAM + *Bacillus subtilis*) showed the best results among the growth characteristics.

Key words: Marigold, terminal cutting, media, container.

1. Introduction

Tagetes is a genus of 50 species in which they are annual or perennial, which is mostly herbaceous plants in the family Asteraceae. Marigold is one of the most important flowering annuals that is widely cultivated all over India. Their demand is increasing throughout the year due to their attractive colour, shape, size and good keeping quality. It is a major source of carotenoid pigment for poultry industry to provide the yellow colour of egg yolk and is also an antagonistic crop in controlling the nematode population. Marigold is easy to cultivate and show wider adaptability to the environment. Marigold is propagated by seeds and the F_1 hybrids are propagated by herbaceous cuttings. It is widely used as a loose flower in garland making. For the nursery growers, they provide a profitable income and there is an increased demand for their production among the nursery growers. Therefore, the present investigation has been formulated to standardize cost effective nursery techniques in marigold.

2. Materials and methods

The research was conducted at the Department of Floriculture and Landscape Architecture, Horticultural College and Research Institute, Coimbatore. The experiment was carried out in Completely Randomized Design with six treatments and replicated thrice, T_1:Cocoplug, T_2: Non-woven plug + Cocopeat + Vermicompost + VAM + *Bacillus subtilis*, T_3:Non-woven plug + Standardized media {Native soil (25%) + Cocopeat (50%) + Vermicompost (15%) + Sand (10%), T_4: Protray + Cocopeat + Vermicompost + VAM + *Bacillus subtilis*, T_5: Protray + Standardized media {Native soil (25%) + Cocopeat (50%) + Vermicompost (15%) + Sand (10%)} and T_6: Protray + Cocopeat as control. The cuttings taken were given a slant cut using sharp secateur and planted in the different containers filled with the media as detailed above, observations were recorded on survival percentage, shoot girth, number of leaves, number of lateral roots, shoot length, root length, fresh weight of leaf, dry weight of leaf, leaf area, number

Commented [dj1]: Please include the sequential introductions for the concepts of "three repetitions" and "six treatments" that are mentioned in the abstract.

Commented [dj2]: In response, this introduction presents marigold, a significant floral plant in India with vivid color, lovely shape, moderate size, and good fresh-keeping quality. Marigold is also the main source of carotene for the pigment found in egg yolks and an antagonistic crop that helps reduce nematodes. Subsequently, it immediately contributes to the advancement of standardized, productive marigold growing technology. Instead of beginning with your content, the development of a certain cultivation technology typically indicates that there are some deficiencies in plant seedling raising at this point. Perhaps you could summarize the research that has been done on marigold cultivation in India and even overseas. On the one hand, you could learn about the current state of marigold cultivation, and on the other, you could find out if anyone has published a paper outlining an effective method for developing seedlings.

Commented [dj3]: Non-woven plugs and Protray are chosen for T3 and T4 substrates, respectively, in the Materials and Methods column. What distinctions and implications do they have? The following does not have a formal introduction.

of lateral branches, length of side branches, plant height, fresh weight of root, dry weight of root, root volume. The results were statistically analysed using AGRES software package and MS Excel® spreadsheet.

3. Result and Discussion

3.1 Vegetative propagation – Terminal cutting

3.1.1 Survival percentage (%)

There was significant difference among the different treatment with regard to survival percentage of cuttings. Highest survival percentage was recorded in terminal cuttings of *Tagetes sp* propagated in Non-woven plug + Cocopeat + Vermicompost + VAM + *Bacillus subtilis* (T_2) upto 30th day after propagation (78.64% and 81.72%) after 15th and 30th day respectively. Least survival percentage was recorded in cuttings raised in protray with cocopeat (T_6) media (53.75% and 58.22% after 15th and 30th day respectively). When *Bacillus subtilis* was incorporated into the nursery media, they form better colonization of root and it stimulates the plants to activate their natural resistance against pathogens. This result was in accordance with the findings reported by Hassan *et al.* (2010) [1] which stated that *Bacillus subtilis* have the capability to suppress the phytopathogens by their production of secondary metabolites which increases the survival percentage.

3.1.2 Vegetative parameters

The length (10.77 cm) and girth (0.35 mm) of shoots emerging from cuttings was also significantly improved in cuttings raised in Non-woven plug + Cocopeat + Vermicompost + VAM + *Bacillus subtilis* (T_2) after 15th day of planting. After 30th day of propagation, length of shoots attained a height (16.33 cm) and a girth (0.50 mm). Least length (6.75 cm and 12.00 cm) and girth of shoots (0.22 mm and 0.35 mm) was observed in treatment protray with cocopeat (T_6) media after 15th and 30th day of planting. The results are in accordance with the findings in *Celosia cristata* when there is a great improvement in the lateral meristematic tissues leading to the increase of shoot girth by the application of vermicompost owing to the supply of nutrients which enhances the beneficial microorganisms for the supplement plant growth along with the panchagavya where organic nutrient along with the bio regulators were found to be effective as reported by Sendhilnathan *et al*. (2021) [9]. An increased number of lateral branches were observed in plants grown in T_2 (2.88 and 4.77) while it was the least in T_6 (1.44 and 2.66) after 15th and 30th day of planting. These results are in accordancewith the findings of (Sardoei *et al.*, 2014) [8]with the result that the application of 50% vermicompost improved the physical and chemical properties of the pot culture media thereby significantly increasing the growth and flowering characters in *Tagetes sp* by their nutrient supply and also it had high specific area which provides the large porosity for their better aeration of the nutrients which tends to increase the length of lateral shoots under greenhouse conditions. Plants raised in the treatment T_2 also recorded significantly lengthier lateral branches (5.94 cm and 7.55 cm) when compared to all other treatments and control (3.66 cm and 5.16 cm) after 15th and 30th day of planting. Significance was observed with regard to plant height in the treatment T_2 (17.13 cm and 24.10 cm) after 15th and 30th day of planting while it was least in control (9.50 cm and 14.55 cm) (Fig 1 and Fig 2). The results are in accordance with the

Commented [dj4]: The study's indexes—activity rate, stem diameter, number of leaves, number of lateral roots, stem length, root length, fresh weight of leaves, dry weight of leaves, leaf area, number of lateral branches, length of lateral branches, plant height, fresh weight of roots, dry weight of roots, and root volume—are introduced in the materials and methods column. Could you also add the carotene content and the nematode control index that were mentioned in the introduction? Additionally, could you add the assessment index that was mentioned in the introduction regarding bright color, attractive shape, and high freshness? Creating an effective cultivation technique requires more consideration to quality than just growth rate.

Commented [dj5]: You cannot believe that the addition of Bacillus subtilis increases the survival rate of plant cuttings. The T6 substrate only includes Protray and a non-woven plug, after all. Consequently, we are unable to assess how much Bacillus subtilis increases the survival rate in this experiment. Maybe you can pinpoint which secondary metabolites are present in the matrix that can suppress infections.

Commented [dj6]: The comparison between "T2" and "T6" treatments, in my opinion, is incredibly loose. Given that the substrate of the "T6" treatment is deficient in nutrients compared to the "T2" treatment and solely consists of cocopeat and protray, it is doubtful that the substrate of the "T6" treatment contains only cocopeat during manufacturing. It is feasible to assess the impact of vermicompost in the "T2" treatment substrate by adding a treatment substrate containing soil and comparing it with the "T2" treatment substrate. Ultimately, it is necessary to measure a few physiological indices because indirect supposition alone will not lead to the conclusion that vermicompost can encourage plant lateral branch elongation.

findings of Kameswari *et al*. (2014) [2] reported greater nutrient availability in different media in which the combination of cocopeat + sand + FYM + vermicompost recorded the greatest height of the plant in *Dendranthema grandiflora*. The combined application of cocopeat and vermicompost has micropores. The soil with micropores has higher water holding capacity which enhances the growth characters by increasing the height of the plant. The highest number of leaves (7.44 and 11.55) was significantly highest in the plants raised in non-woven plug + Cocopeat + Vermicompost + VAM + *Bacillus subtilis* (T_2) after 15th and 30th day of planting. The least number of leaves was recorded in control T_6 with (5.00 and 7.33) after 15th and 30th day of planting. The results of Olle (2016) [5] that application of 25% vermicompost increased the number of leaves in *Solanum lycopersicum* are in close conformity with the present findings. Thus, vermicompost have a high portion of humic substances especially humic acid, fulvic acid and humin which provides the numerous sites for the chemical reactions to occur and provides the microbial components which especially enhances the plant growth like number of leaves. Highest leaf area was recorded in plants raised in the treatment T_2 (21.40 cm^2 and 32.38 cm^2) while the least was observed in control T_6 (14.23 cm^2 and 21.32 cm^2) after 15th and 30th day of planting. These results are in close conformity with the findings of Mupambwa *et al*. (2017) [4] who observed in *Tagetes sp* that the application of 50% fly ash vermicompost has the higher concentration of Nitrogen (N), Phosphorous (P) and Potassium (K) content along with the supply of maximum nutrients which results in the superior improvement in the leaf area. Fresh weight and dry weight of leaves was also observed to be significantly higher in plants raised in the treatment T_2 (1.52 g and 1.07 g) respectively after 15th day of planting and (1.55 g and 1.08 g) after 30th day of planting respectively. The least fresh weight and dry weight of leaves was recorded by control T_6 (1.24 g and 1.00 g) and (1.26 g and 1.01 g) after 15th and 30th day of planting. The results of this experiment are in accordance with the findings of Thangam *et al*. (2009) [11]with the different growing media like soil with sand, FYM, vermicompost, rice husk and cocopeat (3:1) in *Gerbera jamesonii* and analysed the significant difference in the growth parameters viz., fresh and dry weight of the leaf increases with the increased concentration of vermicompost due to the better growth and development under polyhouse conditions.

Commented [dj7]: Based on the experimental results, we can conclude that vermicompost is present in the soil and that it can stimulate plant development because the plants treated with "T2" grow well. You already know that vermicompost increases plant leaves, lengthens lateral branches, and increases seedling survival rates, therefore you don't need to write a lengthy essay discussing the relationship between different morphological indices and earthworm feces.Thus, simply provide an example before going into great depth about the physiological mechanism.

Commented [dj8]: Furthermore, since you haven't examined the relative amounts of potassium, phosphate, and nitrogen in the soil, you cannot extrapolate the findings of other people's studies to support the conclusions of your own. Specific physiological markers must also be measured.

3.1.3 Rooting parameters

Rooting parameters were significantly improved in plants raised with Non-woven plug + Cocopeat + Vermicompost + VAM + *Bacillus subtilis* (T_2). Highest number of roots per plant was observed in T_2 (8.11 and 16.77) on 15th and 30th day of planting. Least number of roots was observed in plants raised in control T_6 (4.88) on 15th day and (8.77) on 30th day. Similar results were found in accordance with the Khayyat *et al*. (2007) [3]in which they observed the growth and development of *Epipremnum aureum* and reported that the improved number of lateral roots and root formation by the application of substrate like cocopeat media have better aeration, good drainage conditions and increased water holding capacity. Root length was also significantly improved in plants raised in T_2 (6.36 cm and 7.77cm) on 15th day and 30th day of planting. The results of the experiment are in accordance with the findings of Sultana *et al*. (2015) [10] in *Zinnia elegans* that the vermicompost plays an important role in the physical and chemical properties of the plant and also the availability of N, P and K in the vermicompost media which increases the root length by 8 to 10% than the other treatments. Highest fresh

weight of roots was registered by plants raised in non-woven plug + Cocopeat + Vermicompost + VAM + *Bacillus subtilis* (T_2) with (1.46 g and 1.47g) after 15th and 30th day of planting, while the least fresh weight of roots was recorded in control (1.13 g and 1.14 g). With regard to dry weight of roots, highest weight was observed in plants raised in T_2 (1.02 g and 1.04 g) after 15th and 30th day of planting, while the least fresh weight of roots was recorded in control (0.99 g and 1.00 g). Inoculation of VAM in improved dry weight of root in *Dendranthema grandiflora* has been earlier reported by (Prasad et al., 2012) [6]. The volume of roots was also influenced significantly in plants raised in the treatment T_2 (1.26 cm^3 and 1.34 cm^3), while the least root volume was recorded in control (0.99 cm^3 and 1.02 cm^3) after 15th and 30th day of planting respectively. Similar results were found in *Calendula officinalis* as reported by Sardoei (2014) [7] that 20% vermicompost has thermophilic properties resulting in the amendment of soil structure and productivity and also increased the microbial population, meanwhile increasing the water retention capacity leading to the highest root volume.

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Fig 1. Influence of different media and containers on plant height of *Tagetes sp* terminal cutting on 15th day

Fig 2. Influence of different media and containers on plant height of *Tagetes sp* terminal cutting on 30th day

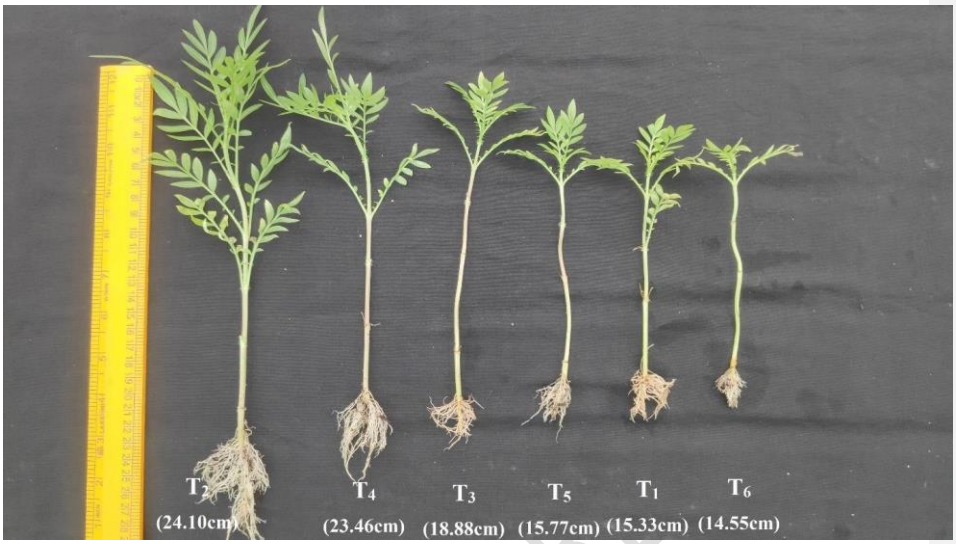

Table 1: Influence of different media and containers growth parameters of Marigold terminal cuttings (15th day after raising the cutting)

Treatments	Survival percentage (%)	Shoot length (cm)	Shoot girth (mm)	Number of lateral branches (nos)	Length of lateral branch (cm)	Plant height (cm)	Number of leaves (nos)
T_1	59.84	6.83	0.25	2.11	4.52	10.10	6.00
T_2	78.64	10.77	0.35	2.88	5.94	17.13	7.44
T_3	64.56	8.66	0.24	1.55	3.77	13.86	5.11
T_4	72.34	9.05	0.28	2.44	4.72	15.36	6.77
T_5	62.45	8.44	0.24	1.77	3.83	13.52	5.44
T_6	53.75	6.75	0.22	1.44	3.66	9.50	5.00
Mean	**65.26**	**8.42**	**0.25**	**2.03**	**4.37**	**13.25**	**5.96**
SE.d	**3.30**	**0.95**	**0.03**	**0.36**	**0.46**	**1.03**	**0.65**
CD @ 5%	**7.19****	**2.07****	**0.08****	**0.79****	**1.00****	**2.25****	**1.42***

Table 2: Influence of different media and containers growth parameters of Marigold terminal cuttings (15th day after raising the cutting)

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Treatments	Leaf area (cm^2)	Fresh Weight of Leaf (g)	Dry Weight of Leaf (g)	Number of lateral roots (nos)	Root length (cm)	Fresh Weight of Root (g)	Dry Weight of Root (g)	Root volume (cm^3)
T_1	11.68	1.44	1.03	5.11	3.27	1.23	1.00	1.00
T_2	21.40	1.52	1.07	8.11	6.36	1.46	1.02	1.26
T_3	18.20	1.45	1.04	8.00	5.20	1.26	1.00	1.18
T_4	20.48	1.49	1.06	8.05	6.31	1.39	1.01	1.23
T_5	19.87	1.40	1.03	6.85	5.08	1.43	1.00	1.18
T_6	14.23	1.24	1.00	4.88	2.75	1.13	0.99	0.99
MEAN	**17.87**	**1.42**	**1.03**	**7.03**	**4.83**	**1.31**	**1.00**	**1.14**
SE.d	**0.89**	**0.03**	**0.01**	**0.39**	**0.25**	**0.00**	**NS**	**0.01**
CD @ 5%	**1.95****	**0.07****	**0.04****	**0.86****	**0.56****	**0.00****	**NS**	**0.04****

Table 3: Influence of different media and containers growth parameters of Marigold terminal cuttings (30th day after raising the cutting)

Treatments	Survival percentage (%)	Shoot length (cm)	Shoot girth (mm)	Number of lateral branches (nos)	Length of lateral branch (cm)	Plant height (cm)	Number of leaves (nos)
T_1	63.68	12.44	0.38	3.00	7.00	15.32	9.11
T_2	81.72	16.33	0.50	4.77	7.55	24.10	11.55
T_3	67.82	15.77	0.40	3.11	6.72	19.28	8.22
T_4	74.48	16.00	0.43	3.44	7.50	23.46	8.88
T_5	66.92	13.55	0.36	2.77	6.27	16.77	7.55
T_6	58.22	12.00	0.35	2.66	5.16	14.55	7.33
MEAN	**68.78**	**14.33**	**0.41**	**3.37**	**6.55**	**18.69**	**8.78**
SE.d	**2.48**	**0.84**	**NS**	**0.29**	**0.33**	**0.78**	**0.56**
CD @ 5%	**5.40****	**1.83****	**NS**	**0.64****	**0.73****	**1.71****	**1.229****

Table 4: Influence of different media and containers growth parameters of Marigold terminal cuttings (30th day after raising the cutting)

Treatments	Leaf area (cm^2)	Fresh Weight of Leaf (g)	Dry Weight of Leaf (g)	Number of lateral roots (nos)	Root length (cm)	Fresh Weight of Root (g)	Dry Weight of Root (g)	Root volume (cm^3)
T_1	21.81	1.47	1.06	9.22	2.88	1.23	1.03	1.04
T_2	32.38	1.55	1.08	16.77	7.77	1.47	1.04	1.34
T_3	27.18	1.49	1.05	14.66	3.51	1.28	1.00	1.29
T_4	31.03	1.50	1.06	16.44	7.46	1.46	1.02	1.30
T_5	26.03	1.42	1.04	13.11	3.22	1.45	1.01	1.23
T_6	21.32	1.26	1.01	8.77	2.55	1.14	1.00	1.02
MEAN	**26.62**	**1.45**	**1.05**	**13.16**	**4.34**	**1.33**	**1.00**	**1.20**
SE.d	**1.44**	**0.02**	**0.01**	**0.37**	**0.41**	**0.01**	**NS**	**0.02**
CD @ 5%	**3.14****	**0.02****	**0.04****	**0.80****	**0.90****	**0.04****	**NS**	**0.05****

4. Conclusion

Terminal cuttings of marigold are best propagated in non-woven plug filled with media comprising of cocopeat + vermicompost + VAM + *Bacillus subtilis* (T_2). The survival percentage and growth parameters viz., number of leaves, number of lateral branches, length of the lateral branch, shoot girth, shoot length, leaf area, fresh weight of leaf, dry weight of the leaf, fresh weight of the root, dry weight of the root and root volume were highly significant in the above media.

Commented [dj11]: I'm a little perplexed about this; the "T2" therapy is having excellent results at this point in every way, but when we move the aforementioned seedlings into a larger planting tray or a field, what happens to their individual follow-up, which needs our ongoing attention? The "T2" treatment's potential applicability to field substrates as well as the question of whether substrate costs are economically related to the value and advantages of plants both pique my curiosity.

REFERENCES

1. Hassan, M.N., A.M. Osborn, and F.Y. Hafeez. 2010. "Molecular and biochemical characterizationof surfactin producing Bacillus species antagonistic to *Colletotrichum falcatum* Went causing sugarcane red rot." *African Journal of Microbiology Research* 4 (20):2137-2142.
2. Kameswari, P.L., A. Girwani, and A. Padmavathamma. 2014. "Effect of different potting media mixtures on growth and flowering of chrysanthemum (*Dendranthema grandiflora* T.)." *Progressive Horticulture* 46 (2):314-318.
3. Khayyat, M., F. Nazari, and H. Salehi. 2007. "Effects of different pot mixtures on pothos (*Epipremnum aureum* Lindl. and Andre 'Golden Pothos') growth and

development." *American-Eurasian Journal of Agricultural and Environmental Science* 2 (4):341-348.
4. Mupambwa, H.A., N.S. Lukashe, and P.N.S. Mnkeni. 2017. "Suitability of fly ash vermicompost as a component of pine bark growing media: effects on media physicochemical properties and ornamental marigold (*Tagetes* spp.) growth and flowering." *Compost science & utilization* 25 (1):48-61.
5. Olle, M. 2016. "The effect of vermicompost based growth substrates on tomato growth." *Agraarteadus: journal of agricultural science: Akadeemilise Põllumajanduse Seltsi väljaanne* 1.
6. Prasad K, Aggarwal A, Yadav K, Tanwar. Impact ofdifferent levels of superphosphate using arbuscular mycorrhizal fungi and Pseudomonas fluorescens on *Chrysanthemum indicum* L. Journal of soil science and plant nutrition 2012;12(3):451-462.
7. Sardoei, A.S. 2014. "Vermicompost effects on the growth and flowering of marigold (*Calendula officinalis*)." *European Journal of Experimental Biology* 4 (1):651-655.
8. Sardoei, A.S., A. Roien, T. Sadeghi, F. Shahadadi, and T.S. Mokhtari. 2014. "Effect of vermicompost on the growth and flowering of African Marigold (*Tagetes erecta*)." *American-Eurasian Journal of Agricultural and Environmental Sciences* 14:631-635.
9. Sendhilnathan, R., E. Balaraman, M. Rajkumar, R. Sureshkumar, and T. Barathkumar. 2021. "Influence of organic nutrients and bio regulators on certain growth and flower quality attributes of celosia (*Celosia cristata* L.)." *Plant Archives* 21 (1):2220-2223.
10. Sultana, S., M.A. Kashem, and A.K. Mollah. 2015. "Comparative assessment of cow manure vermicompost and NPK fertilizers and on the growth and production of zinnia (*Zinnia elegans*) flower." *Open Journal of Soil Science* 5 (09):193.
11. Thangam, M., M. Ladaniya, and V. Korikanthimath. 2009. "Performance of gerbera varieties in different growing media under coastal humid conditions of Goa." *Indian Journal of Horticulture* 66 (1):79-82.