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# SHOOT GROWTH AND SUCCESS OF PROPAGATION THROUGH TERMINAL CUTTINGS AS INFLUENCED BY ROOTING MEDIA IN MARIGOLD

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**ABSTRACT**

An experiment was carried in factorial concept with two factors *i.e.*, varieties at two levels and rooting media at eight levels thus making 16 combinations which were replicated twice. The effect of varieties, rooting media and their interactions were found to be significant on different rooting parameters.The variety, Bidhan Marigold 1 recorded the earliest sprouting of cuttings (8.28 days) as compared to Bidhan Marigold 2 (8.33 days). Among the rooting media, the earliest sprouting (7.07 days) was recorded by $M_8$– soil : vermicompost : coco peat : sawdust (1:1:1:1) v/v+ mycorrhiza, which was significantly superior to $M_6$–soil : vermicompost : cocopeat:rice husk (1:1:1:1)v/v + mycorrhiza (7.55 days) and $M_4$ – soil : vermicompost : coco peat (1:1:1) v/v + mycorrhiza (7.67 days). Maximum delay was observed for sprouting of terminal cuttings planted in $M_1$ – soil. (9.28 days). The other shoot parameters *viz.*, number of shoots per cutting, length of longest shoot, number of leaves per cutting, leaf area per cutting, leaf chlorophyll content, fresh and dry weight of shoots and whole plant were found to be significantly influenced by variety and rooting media where the above media were found to show superior performance.

***Key words :*** Sprouting, Number, Leaf area and Leaf chlorophyll.

## Introduction

Marigold (*Tagetes erecta* L.) is one of the most important commercial flower crops grown in India. The crop is said to be native of Mexico. It belongs to the family *Asteraceae* and propagated by seed and terminal cuttings. Marigold is normally propagated through seeds but due to its cross pollinated nature, true-to-type of plants are not obtained and hence the flowers borne on such plants exhibit wide variations. Therefore, an alternative propagation technique *i.e.*, through terminal cuttings is becoming popular, of late, to overcome this problem. This method is commonly followed for maintaining the purity of varieties. The vegetative propagation of marigold through terminal cutting helps to reduce the cost of seed production. It will facilitate for easy improvement of planting material capable of giving more flower yield than existing sexual method. A higher number of roots could be seen in terminal cuttings of marigold than in seed propagation of marigold, helps to increase number of branches, maximum leaves per plant, maximum plant height, large flower bloom than those plants propagated sexually through seed. So, commercialisation of vegetative propagation has gained importance now- a- days because consumers prefer flower quality, large bloom, loose flower and more vigorous plants with more number of leaves and branches for pot plants. Therefore, vegetative propagation of marigold is advocated for both field and potted cultivation.

## Materials and Methods

Experiment was carried out at college farm, College of Horticulture, Dr. Y.S.R. Horticultural University, Venkataramannagudem, West Godavari District of Andhra Pradesh during *rabi*, 2017-2018. Experiment was laid out in completely randomised design with factorial concept. Factor one (V) consisted of two levels one being

Bidhan Marigold-1 (BM 1) and another Bidhan Marigold–2(BM 2) and factor two consists of 8 levels of rooting media: $M_1$ – soil, $M_2$ – soil + mycorrhiza, $M_3$ – soil: vermicompost (1:1) v/v + mycorrhiza, $M_4$ – soil: vermicompost: coco peat (1:1:1) v/v + mycorrhiza, $M_5$ – soil: vermicompost: rice husk (1:1:1) v/v + mycorrhiza, $M_6$– soil: vermicompost: coco peat: rice husk (1:1:1:1) v/v + mycorrhiza, $M_7$ – soil: vermicompost: saw dust (1:1:1) v/v + mycorrhiza and $M_8$– soil: vermicompost: coco peat: saw dust (1:1:1:1) v/v + mycorrhiza. Thus, there were 16 treatment combinations and were repeated twice. Mycorrhiza was applied at the rate of 2 g per plant (Neelima *et al*., 2016). Shoot parameter observations like Days to first sprouting of terminal cuttings, Number of shoots per cutting, Length of longest shoot (cm), Number of branches per cutting, Number of leaves per cutting, Leaf area per cutting ($cm^2$), Leaf chlorophyll content (SPAD units), Fresh weight of shoots, Fresh weight of whole plant, Dry weight of shoots and Dry weight of whole plant were recorded at regular intervals starting from the time of shifting and at 30, 60 and 90 days after shifting (DAS) of the cuttings. Whereas, Root to shoot ratio was recorded at the time of shifting the rooted cuttings on dry weight basis. The experimental data pertaining to all the characters studied were subjected to statistical analysis of variance technique as described by Panse and Sukhatme (1997).

## Results and Discussion

### Days to first sprouting of terminal cuttings (d)

The variety Bidhan Marigold 1 recorded the earliest sprouting of cuttings (8.28 days) as compared to Bidhan Marigold 2 (8.33 days). Among the rooting media, the earliest sprouting (7.07 days) was recorded by $M_8$– soil: vermicompost : coco peat : sawdust (1:1:1:1) v/v + mycorrhiza which was significantly superior to $M_6$– soil : vermicompost : coco peat : ricehusk (1:1:1:1) v/v + mycorrhiza (7.55 days) and $M_4$ – soil : vermicompost : coco peat (1:1:1) v/v + mycorrhiza (7.67 days). Maximum delay was observed for sprouting of terminal cuttings planted in $M_1$ – soil. (9.24 days).

Bud sprouting is mainly attributed to the quantum of stored carbohydrates in the cuttings. The coco peat amended media gave maximum plant height on account of high porosity, nutritional value and good water holding capacity. Early sprouting in coco peat-based media was also reported by Lyngdoh *et al*. (2015) during scale propagation in lilium. Vermicompost being a rich source of macro and micronutrients growth hormones, enzymes, antibiotics and vitamins might also had contributed for an earlier sprouting of buds (Bawalkar, 1992). Further, the mycorrhizal association might also had increased the Phyto availability of micronutrients, *e.g*., iron, copper, zinc, manganese *etc*. as the hyphal structures permeate the soil and obtain scarce and relatively immobile elements, by releasing weak phytic acids, which break the bonding between soil (positively charges ion) and cationic micro nutrients and makes it available to the plant more effectively than the root hairs of a normal non-mycorrhizal infected plant roots (Smith and Read, 2008).

### Number of shoots per cutting

The variety Bidhan Marigold 1 exhibited the higher number of shoots per cutting (2.59) than Bidhan Marigold 2 (2.57). Among the rooting media, the highest number of shoots per cutting (3.31) was recorded by $M_8$ – soil : vermicompost : coco peat : saw dust (1:1:1:1) v/v + mycorrhiza followed by $M_6$ – soil : vermicompost : coco peat : rice husk (1:1:1:1) v/v + mycorrhiza (2.8) and $M_4$ – soil : vermicompost : coco peat (1:1:1) v/v + mycorrhiza (2.63). The lowest number of shoots per cutting (2.13) was recorded on $M_1$ – soil.

Terminal cuttings planted in coco peat showed maximum number of shoots, which might be due to decomposition of lignins present in coco peat resulting in the formation of humic fractions (Kadalli *et al*., 2001). Coco peat had a property of retaining more nutrients and also helpful in increasing the number of shoots per cutting as reflected in the present study. Further, growth regulators such as cytokinin, amino acid, vitamins, enzymes, some other secretions and many useful microbes such as heterotrophic bacteria, fungi, actinomycetes including nitrogen fixers, phosphate solubilizers present in the vermicompost favoured the development of more number of shoots per cuttings. Similar findings were observed by Anburani and Vidhyapriyadharshini (2008) in Jasmine, Nagalakshmi *et al*. (2010) in Anthurium, Karuppaiah and Sendilnathan (2011) in orchid, Kumar *et al*. (2013 a & b) in gladiolus, Shlre *et al*. (2014) in coleus and Himanshu and Ajit (2015) in rose. Vesicular arbuscular mycorrhiza is a fungi that colonize the plant root system and develop symbiotic association by forming a network of fine filaments associating with root system would have facilitated increase in absorption of nutrients such as N, K, Mg and Zn and water from the soil (Smith and Read, 2008).

### Length of longest shoot (cm)

The variety Bidhan Marigold 1 exhibited more length of longest shoot per cutting (13.54 cm) than Bidhan Marigold 2 (12.76 cm). Among the rooting media, the more length of longest shoot per cutting (14.53 cm) was recorded by $M_8$ – soil : vermicompost : coco peat : saw dust (1:1:1:1) v/v + mycorrhiza which was on par with $M_6$ – soil : vermicompost : coco peat : rice husk (1:1:1:1) v/v + mycorrhiza (13.98 cm) and $M_4$ – soil : vermicompost : coco peat (1:1:1) v/v + mycorrhiza (13.91 cm). The minimum length of longest shoot percutting (10.95 cm) was recorded on $M_1$ – soil.

Among the rooting media, the terminal cuttings planted in coco peat recorded the maximum length of sprout. It could be attributed to the adequate supply of oxygen, water and nutrients by the coir pith for the proper functioning of root (Jeyaseeli and Paul Raj, 2010), which might probably facilitated better absorption of moisture and nutrients resulting in shoot elongation to the highest degree. Food in the form of photosynthates provide required energy for cell division and cell elongation thus facilitating maximum length of shoot (Shahab *et al.*, 2013). Norman and Edward (2005) studied the effect of vermicompost on plant growth and reported that vermicompost is a rich source of mineral nutrition and its addition to media increases quality of media by increasing microbial activity and microbial biomass, which are key components in nutrient cycling and production of plant growth regulators. That might have resulted in superior length of longest shoot. Inoculation of bio fertilizers in plants have been known to increase the amount the auxin and cytokinin in the flowers that lead to improved quality parameters *viz.*, length of stalk as disclosed in chrysanthemum (Palagani *et al.*, 2013), gladiolus (Kumar *et al.*, 2013 a & b).

**Number of branches per cutting**

The variety Bidhan Marigold 1 exhibited greater number of branches per cutting (16.44) than Bidhan Marigold 2 (14.84) at 30 days after sowing (15 days after shifting). Among the rooting media, the highest number of branches per cutting (17.63) was recorded by $M_8$ – soil : vermicompost : coco peat : saw dust (1:1:1:1) v/v + mycorrhiza, which was on par with $M_6$ – soil : vermicompost : coco peat : rice husk (1:1:1:1) v/v + mycorrhiza (17.16), but significantly superior to $M_4$ – soil : vermicompost : coco peat (1:1:1) v/v + mycorrhiza (16.46). The lowest number of branches per cutting (12.65) was recorded on $M_1$ – soil.

Terminal cuttings planted in coco peat showed maximum numbers of shoots, which might be due to decomposition of lignins present in coco peat resulting in the formation of humic fractions (Kadalli *et al.*, 2001). Coco peat had a property of retaining more nutrients and also helpful in increasing the number of branches per cutting as reflected in the present study. Further, growth regulators such as cytokinins, amino acid, vitamins, enzymes, some other secretions and many useful microbes such as heterotrophic bacteria, fungi, actinomycetes including nitrogen fixers, phosphate solubilizers are also present in the compost developed in the presence of earthworms. Similar findings were observed by Anburani and Vidhyapriyadharshini (2008) in Jasmine, Nagalakshmi *et al.* (2010) in Anthurium, Karuppaiah and Sendilnathan (2011) in orchid, Kumar *et al.* (2013 a & b) in gladiolus, Shlrene *et al.* (2014) in coleus and Himanshu and Ajit (2015) in rose. Formation of a network of fine filaments would have been facilitated by the mycorrhizal inoculations in the rooting media and such associations with root system could have increased the absorption of nutrients such as N, K, Mg and Zn and water from the soil (Smith and Read, 2008).

**Number of leaves per cutting**

The variety Bidhan Marigold 1 exhibited maximum number of leaves per cutting (18.89), whereas the number of leaves per cutting was minimum in Bidhan Marigold 2 (18.60). Among the rooting media, the maximum number of leaves per cutting (21.80) was recorded by $M_6$ – soil : vermicompost : coco peat : ricehusk (1:1:1:1) v/v + mycorrhiza which was on par with $M_8$ – soil : vermicompost : coco peat : sawdust (1:1:1:1) v/v + mycorrhiza (20.48) and followed by M4 – soil : vermicompost : coco peat (1:1:1) v/v + mycorrhiza (20.38). The minimum number of leaves per cutting (14.95) was recorded on $M_1$ – soil.

The maximum number of leaves per cutting was produced in terminal cuttings planted in coco peat based media combinations, which might be due to superior root development as evident from the earlier paragraphs. The higher moisture retention capacity, porosity and nutrient status of coir pith (Nagarajan *et al.*, 1985) could be the reasons for this higher leafiness in the cuttings planted under such media. Maximum number of leaves with larger leaf area was also found in lilium cultivars grown on medium amended with cocopeat (Nikrazm *et al.*, 2011). Jong *et al.* (2002) also reported the highest number of leaves on a media containing rice hull, sawdust and pine bark (1:1:1; v/v) in lilium cv. 'Orange Pixie', which is also proved in the present study as the media amended with rice husk and saw dust performed well. Vermicompost is known to have increased water holding capacity and enhanced nutrient uptake (Tomati *et al.*, 1988). Addition of cocopeat along with vermicompost as a source of organic nutrients augmented the vegetative growth in lilium. Increased number of leaves in the media amended with vermicompost has also been reported by Moghadam *et al.* (2012) in lilium Asiatic hybrid 'Navona'.

Symbiotic association with mycorrhizae would have facilitated increased absorption of nutrients and hence greater numbers of leaves per cutting were recorded in mycorrhizae inoculated media as compared to non-mycorrhizal media (Smith and Read, 2008). It is interesting to note in the present study that the existence of vermicompost + cocopeat only could show significant effect irrespective of whether the other components like rice husk and saw dust were present or not which might be perhaps due to complementary and synergistic effect of the vermicompost and cocopeat in supplying nutrients and at the same time providing good aeration as well as water holding capacity in the substrate.

**Leaf area per cutting ($cm^2$)**

The leaf area per cutting was found to increase from 40.53 $cm^2$ (at shifting) to 3545.81 $cm^2$ (90 DAS). At 90 DAS, the variety Bidhan Marigold 1 showed maximum leaf area per cutting (4239.88 $cm^2$) than Bidhan Marigold 2 (2851.75$cm^2$). Among the rooting media, at 90 DAS the maximum leafarea per cutting (5935.50$cm^2$) was recorded by $M_6$– soil : vermicompost : coco peat :ricehusk (1:1:1:1) v/v + mycorrhiza which was significantly superior to $M_8$– soil :vermicompost : coco peat : sawdust (1:1:1:1) v/v + mycorrhiza (3781 $cm^2$) and $M_4$ –soil : vermicompost : coco peat (1:1:1) v/v + mycorrhiza (3713 $cm^2$). The minimum leaf area per cutting (2205 $cm^2$) was recorded on $M_1$ – soil.

The highest leaf area was recorded in terminal cuttings planted in coco peat which might be attributed to the better aeration, drainage conditions and moisture retentive capability (Khayyat *et al*., 2007). Nutrient uptake with healthy and strong root system could have boosted the rate of photosynthesis in cocopeat based rooting media gaining much stronger position to nurture the growing leaves and expanding them leading to a maximum leaf area per cutting (Ismail and Asghar, 2007). Maximum number of leaves with larger leaf area was also found in lilium cultivars grown on medium amended with cocopeat (Nikrazm *et al*., 2011). This might be due to the fact that the plant cells grow in size by cell enlargement which in turn requires water. Turgidity of cells helps in extension growth. Thus, plant growth and further development is intimately linked to the water status of the plant. As the water content of the plant decreases, cells shrink and the turgor pressure against cell walls reflexes, results reduction in the leaf area (Taiz and Zeiger, 2006). Cocopeat and vermicompost both holds optimum moisture level and good aeration, which might have increased the leaf area per cutting.

**Leaf chlorophyll content (SPAD units)**

The leaf chlorophyll content was found to increase from 22.70 (at shifting) to 35.13 (90 DAS). At 90 DAS, the variety Bidhan Marigold 1 exhibited the highest leaf chlorophyll content (35.78) as compared to Bidhan Marigold 2 (34.47). Among the rooting media, at 90 DAS the highest leaf chlorophyll content (38.34) was recorded by $M_8$– soil : vermicompost : coco peat : sawdust (1:1:1:1) v/v + mycorrhiza which was significantly superior to $M_6$– soil : vermicompost : coco peat : ricehusk (1:1:1:1) v/v + mycorrhiza (36.95), $M_4$ – soil : vermicompost : coco peat (1:1:1) v/v + mycorrhiza (35.29) and $M_3$ – soil : vermicompost (1:1) v/v + mycorrhiza (34.25). The lowest leaf chlorophyll content (33.37) was recorded on $M_1$ – soil.

Ratnakumari (2014) observed that cuttings with more number of leaves enhanced nutrient uptake thereby increased the photosynthate production and provided sufficient substrate molecules for the metabolic activities of the plants by means of mounting the levels of light harvesting pigments especially chlorophylls. The highest leaf chlorophyll content was recorded in terminal cuttings planted in coco peat which might be attributed to the better physical properties of this medium (Khayyat *et al*., 2007). Nutrient uptake with healthy and strong root system could have boosted the rate of photosynthesis gaining much stronger position to nurture the growing leaves and expanding them leading to maximum leaf chlorophyll content (Ismail and Asghar, 2007). Cocopeat and vermicompost both holds optimum moisture level and good aeration which might have increased the leaf area per cutting.

**Fresh weight of shoots (g)**

At 90 DAS, the variety Bidhan Marigold 1 exhibited the highest fresh weight of shoots (85.40 g) than Bidhan Marigold 2 (59.27 g). Among the rooting media, at 90 DAS the highest fresh weight of shoots (83.01 g) was recorded by $M_8$ – soil : vermicompost : coco peat : saw dust (1:1:1:1) v/v + mycorrhiza followed by $M_6$ – soil : vermicompost : coco peat : rice husk (1:1:1:1) v/v + mycorrhiza (82.43) and M4 – soil : vermicompost : coco peat (1:1:1) v/v + mycorrhiza (74.84). The lowest fresh weight of shoots (61.57) was recorded on $M_1$ – soil.

The terminal cuttings planted in coco peat gave the maximum fresh weight of shoots per cutting because of the favourable physical conditions in the coco peat based rooting and growing media (Cresswell, 1997) resulting in the increased number of leaves, length and number of shoots, which helps in increased fresh weight of shoots. The superiority of vermicompost amended medium for improvement of various growths by providing optimum growing conditions might be responsible for production of heavier stems in this medium. Better quality cut stems in oriental lilies have been reported in media containing cocopeat in combination with other constituents (Treder, 2005).

**Fresh weight of whole plant (g)**

At 90 DAS, the variety Bidhan Marigold 1 exhibited the highest fresh weight of whole plant (292.78 g) than Bidhan Marigold 2 (167.02 g). Among the rooting media, at 90 DAS the highest fresh weight of whole plant (293.59 g) was recorded by $M_8$ – soil : vermicompost : coco peat : saw dust (1:1:1:1) v/v + mycorrhiza on par with $M_6$ – soil : vermicompost : coco peat : rice husk (1:1:1:1) v/v + mycorrhiza (275.36 g) and $M_4$ – soil : vermicompost : coco peat (1:1:1) v/v + mycorrhiza (251.75 g). The lowest fresh weight of whole plant (170.45 g) was recorded on $M_1$ – soil.

The terminal cuttings planted in coco peat + vermicompost based media supported with mycorrhiza gave the maximum fresh weight of whole plant simply because of the corresponding higher fresh weights of roots, shoots and flowers (Cresswell, 1997).

**Dry weight of shoots per plant (g)**

At 90 DAS, the variety Bidhan Marigold 1 exhibited highest dry weight of shoots (46.86 g) than Bidhan Marigold 2 (28.01 g). Among the rooting media, at 90 DAS the highest dry weight of shoots (49.06 g) was recorded by $M_6$ – soil : vermicompost : coco peat : ricehusk (1:1:1:1) v/v + mycorrhiza followed by $M_8$ – soil : vermicompost : coco peat : sawdust (1:1:1:1) v/v + mycorrhiza (42.28 g) and $M_4$ – soil : vermicompost : coco peat (1:1:1) v/v + mycorrhiza (39.91 g). The lowest dry weight of shoots (30.18 g) was recorded on $M_1$ – soil.

The increase in dry weight of shoots per plant in the cocopeat + vermicompost based growing media could be attributed to the increased fresh weight of shoot as explained in the earlier paragraphs. The superiority of cocopeat + vermicompost amended medium inoculated with mycorrhizae was due to the improvement of various growth parameters that might be responsible for production of heavier stems in this medium (Meenakshi *et al*., 2015).

**Dry weight of whole plant (g)**

At 90 DAS, the variety Bidhan Marigold 1 exhibited highest dry weight of whole plant (99.67 g) than Bidhan Marigold 2 (68.76 g). Among the rooting media, at 90 DAS the highest dry weight of whole plant (110.81 g) was recorded by $M_6$ – soil : vermicompost : coco peat : rice husk (1:1:1:1) v/v + mycorrhiza which was on par with $M_8$ – soil : vermicompost : coco peat : sawdust (1:1:1:1) v/v + mycorrhiza (99.81 g) followed by $M_4$ – soil : vermicompost : coco peat (1:1:1) v/v + mycorrhiza (92.16 g). The lowest dry weight of whole plant (63.78 g) was recorded on $M_1$ – soil.

An examination of results on dry weight of whole plant and its components brings into light a fact that those treatments or media where maximum fresh weights were recorded also possessed maximum dry weight values. The favourable physicalproperties of cocopeat, meritorious biological properties of vermicompost coupledwith a better connectivity established by mycorrhizal inoculation in the media would have resulted in the greater assimilation of dry mater. Similar observations were recorded by earlier workers Cresswell (1997) and Meenakshi *et al*. (2015).

**Root to shoot ratio (on dry weight basis)**

The variety Bidhan Marigold 1 exhibited highest root to shoot ratio (0.53) than Bidhan Marigold 2 (0.40). Among the rooting media, the highest root to shoot ratio (0.57) was recorded by $M_6$– soil : vermicompost : coco peat : rice husk (1:1:1:1) v/v + mycorrhiza followed by $M_8$– soil : vermicompost : coco peat : sawdust (1:1:1:1) v/v + mycorrhiza (0.47) and followed by $M_4$ – soil : vermicompost : coco peat (1:1:1) v/v + mycorrhiza (0.47). The lowest root to shoot ratio (0.40) was recorded on M1 – soil.

A treatment combination would be more effective when it takes more time to show a reasonable number of shoots per cutting, because it would have triggered more rooting cofactors and diverted more energy for promoting root development during initial stages thus recording lesser number of shoots shortly after planting (Goudappa, 2016). It is the sustainable development of shoot sprouts that is more important rather than rapid rate of shoot development just immediately after planting the cuttings for experimentation (Agbo and Obi, 2008). In the present study, the terminal cuttings planted in coco peat medium, recorded lower number of shoots per cutting during the initial stages but sustained those shoots till the end probably because there was much balance between root development and shoot development as evident from the data on number of shoots per cutting at 30 and 60 days after shifting. Thus, the merit of such treatments was exhibited in stability by 90 days after planting the cuttings in both root and shoot parameters in spite of back logged situation in respect of shoot parameters in the initial stages of experimentation. The highest root to shoot ratio was recorded in terminal cuttings planted in coco peat might be due to well development of root system relative to

**Table 1 :** Days to first sprouting of terminal cuttings, Number of shoots per cutting, Length of longest shoot (cm) and Number of branches per cutting as influenced by rooting media in marigold varieties.

| Medium / Variety | Days to first sprouting of terminal cuttings | | | Number of shoots per cutting | | | Length of longest shoot (cm) | | | Number of branches per cutting | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BM1 | BM 2 | Mean | BM1 | BM 2 | Mean | BM1 | BM 2 | Mean | BM1 | BM 2 | Mean |
| **$M_1$ –soil** | 9.14 | 9.35 | **9.24** | 2.61 | 1.65 | **2.13** | 11.25 | 10.65 | **10.95** | 14.65 | 10.65 | **12.65** |
| **$M_2$ – soil + mycorrhiza** | 9.09 | 8.93 | **9.01** | 2.45 | 2.15 | **2.30** | 11.85 | 11.02 | **11.43** | 15.95 | 13.31 | **14.63** |
| **$M_3$ – soil: vermicompost (1:1)v/v+mycorrhiza** | 9.05 | 8.94 | **8.99** | 1.95 | 2.95 | **2.45** | 14.11 | 12.31 | **13.21** | 15.31 | 14.32 | **14.81** |
| **$M_4$–soil: vermicompost : cocopeat (1:1:1)v/v+ mycorrhiza** | 7.67 | 7.68 | **7.67** | 2.81 | 2.45 | **2.63** | 14.62 | 13.21 | **13.91** | 16.62 | 16.31 | **16.46** |
| **$M_5$–soil: vermicompost : ricehusk(1:1:1) v/v+ mycorrhiza** | 8.58 | 8.44 | **8.51** | 2.65 | 2.31 | **2.48** | 13.45 | 13.25 | **13.35** | 17.15 | 13.65 | **15.40** |
| **$M_6$–soil :vermicompost: cocopeat: ricehusk (1:1:1:1)v/v+mycorrhiza** | 7.56 | 7.54 | **7.55** | 2.65 | 2.95 | **2.80** | 13.65 | 14.31 | **13.98** | 17.81 | 16.51 | **17.16** |
| **$M_7$ – soil: vermicompost : sawdust(1:1:1)v/v+ mycorrhiza** | 8.53 | 8.31 | **8.42** | 2.81 | 2.31 | **2.56** | 14.35 | 13.15 | **13.75** | 16.95 | 15.82 | **16.38** |
| **$M_8$ –soil: vermicompost : coco peat: sawdust (1:1:1:1)v/v+mycorrhiza** | 7.06 | 7.08 | **7.07** | 2.81 | 3.81 | **3.31** | 14.81 | 14.25 | **14.53** | 17.12 | 18.15 | **17.63** |
| **Mean** | **8.33** | **8.28** | **8.30** | **2.59** | **2.57** | **2.58** | **13.54** | **12.76** | **13.15** | **16.44** | **14.84** | **15.64** |
| **Factor** | **SEm±** | **CD at 5%** | | **SEm±** | **CD at 5%** | | **SEm±** | **CD at 5%** | | **SEm±** | **CD at 5%** | |
| **Variety (V)** | 0.01 | 0.03 | | - | NS | | 0.18 | 0.53 | | 0.37 | 1.10 | |
| **Medium (M)** | 0.15 | 0.46 | | 0.07 | 0.20 | | 0.25 | 0.75 | | 0.32 | 0.94 | |
| **VXM** | 0.19 | 0.56 | | 0.12 | 0.35 | | 0.34 | 0.99 | | 0.48 | 1.42 | |

**Table 2 :** Number of leaves per cutting, Leaf area per cutting ($cm^2$), Leaf chlorophyll content (SPAD units) and Fresh weight of shoots per cutting (g) as influenced by rooting media in marigold varieties

| Medium / Variety | Number of leaves per cutting | | | Leaf area per cutting ($cm^2$) | | | Leaf chlorophyll content (SPAD units) | | | Fresh weight of shoots per cutting (g) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **BM1** | **BM 2** | **Mean** | **BM1** | **BM 2** | **Mean** | **BM1** | **BM 2** | **Mean** | **BM1** | **BM 2** | **Mean** |
| **$M_1$ –soil** | 13.95 | 14.15 | **14.95** | 1935 | 2475 | **2205** | 33.94 | 32.81 | **33.37** | 61.30 | 61.83 | **61.57** |
| **$M_2$ – soil + mycorrhiza** | 16.62 | 14.65 | **15.63** | 3411 | 2465 | **2938** | 35.45 | 32.83 | **34.14** | 87.40 | 47.30 | **67.35** |
| **$M_3$ – soil: vermicompost (1:1)v/v+mycorrhiza** | 19.15 | 17.95 | **18.55** | 3242 | 2928 | **3085** | 34.33 | 34.18 | **34.25** | 88.15 | 48.71 | **68.43** |
| **$M_4$–soil:vermicompost: cocopeat(1:1:1)v/v+ mycorrhiza** | 21.31 | 19.45 | **20.38** | 5376 | 2050 | **3713** | 35.48 | 35.10 | **35.29** | 94.55 | 55.13 | **74.84** |
| **$M_5$–soil: vermicompost: ricehusk(1:1:1) v/v+ mycorrhiza** | 19.12 | 19.31 | **19.21** | 4653 | 2330 | **3491** | 36.77 | 31.93 | **34.35** | 73.50 | 65.68 | **69.59** |
| **$M_6$–soil :vermicompost: cocopeat: ricehusk (1:1:1:1)v/v+mycorrhiza** | 20.65 | 22.95 | **21.80** | 7682 | 4189 | **5935** | 37.01 | 36.89 | **36.95** | 102.80 | 62.06 | **82.43** |
| **$M_7$–soil: vermicompost: sawdust(1:1:1)v/v+ mycorrhiza** | 19.01 | 18.95 | **18.98** | 3490 | 2945 | **3217** | 34.56 | 34.14 | **34.35** | 92.25 | 50.76 | **71.51** |
| **$M_8$–soil:vermicompost : coco peat: sawdust (1:1:1:1)v/v+mycorrhiza** | 21.31 | 19.65 | **20.48** | 4130 | 3432 | **3781** | 38.73 | 37.94 | **38.34** | 83.25 | 82.77 | **83.01** |
| **Mean** | **18.89** | **18.60** | **18.74** | **4239.88** | **2851.75** | **3545.81** | **35.78** | **34.47** | **35.13** | **85.40** | **59.27** | **72.34** |
| **Factor** | **SEm±** | **CD at 5%** | | **SEm±** | **CD at 5%** | | **SEm±** | **CD at 5%** | | **SEm±** | **CD at 5%** | |
| **Variety (V)** | 0.06 | 0.19 | | 327.18 | 959.59 | | 0.30 | 0.90 | | 6.15 | 18.05 | |
| **Medium (M)** | 0.47 | 1.39 | | 217.57 | 638.12 | | 0.33 | 0.98 | | 1.48 | 4.35 | |
| **VXM** | 0.60 | 1.78 | | 364.76 | 1069.81 | | 0.48 | 1.41 | | 4.49 | 13.18 | |

**Table 3 :** Fresh weight of whole plant (g), Dry weight of shoots per cutting (g), Dry weight of whole plant (g) and Root and Shoot Ratio (On dry weight basis) as influenced by rooting media in marigold varieties.

| Medium / Variety | Fresh weight of whole plant (g) | | | Dry weight of shoots per cutting (g) | | | Dry weight of whole plant (g) | | | Root and Shoot Ratio (On dry weight basis) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BM1 | BM 2 | Mean | BM1 | BM 2 | Mean | BM1 | BM 2 | Mean | BM1 | BM 2 | Mean |
| **$M_1$ –soil** | 177.71 | 163.18 | **170.45** | 34.75 | 25.60 | **30.18** | 69.11 | 58.45 | **63.78** | 0.44 | 0.36 | **0.40** |
| **$M_2$ – soil + mycorrhiza** | 249.20 | 139.70 | **194.45** | 27.51 | 34.75 | **31.13** | 67.56 | 71.80 | **69.68** | 0.51 | 0.34 | **0.43** |
| **$M_3$ – soil: vermicompost (1:1)v/v+mycorrhiza** | 246.30 | 173.26 | **209.78** | 41.62 | 22.50 | **32.06** | 86.38 | 59.25 | **72.82** | 0.55 | 0.36 | **0.45** |
| **$M_4$–soil: vermicompost: cocopeat (1:1:1)v/v+ mycorrhiza** | 307.71 | 195.78 | **251.75** | 57.02 | 22.80 | **39.91** | 119.32 | 65.00 | **92.16** | 0.51 | 0.43 | **0.47** |
| **$M_5$–soil: vermicompost: ricehusk (1:1:1) v/v+ mycorrhiza** | 267.03 | 160.03 | **213.53** | 42.81 | 32.60 | **37.71** | 89.67 | 79.75 | **84.71** | 0.51 | 0.40 | **0.46** |
| **$M_6$–soil : vermicompost: cocopeat:ricehusk (1:1:1:1)v/v+mycorrhiza** | 416.86 | 133.86 | **275.36** | 75.02 | 23.10 | **49.06** | 147.71 | 73.90 | **110.81** | 0.69 | 0.45 | **0.57** |
| **$M_7$–soil: vermicompost: sawdust(1:1:1)v/v+ mycorrhiza** | 295.42 | 165.16 | **230.29** | 44.75 | 29.60 | **37.18** | 94.64 | 67.70 | **81.17** | 0.45 | 0.46 | **0.45** |
| **$M_8$–soil: vermicompost: coco peat:sawdust (1:1:1:1)v/v+mycorrhiza** | 382.00 | 205.17 | **293.59** | 51.45 | 33.10 | **42.28** | 125.36 | 74.25 | **99.81** | 0.56 | 0.39 | **0.47** |
| **Mean** | **292.78** | **167.02** | **229.90** | **46.86** | **28.01** | **37.44** | **99.67** | **68.76** | **84.37** | **0.53** | **0.40** | **0.46** |
| **Factor** | **SEm±** | **CD at 5%** | | **SEm±** | **CD at 5%** | | **SEm±** | **CD at 5%** | | **SEm±** | **CD at 5%** | |
| **Variety (V)** | 14.82 | 44.96 | | 4.44 | 13.03 | | 3.68 | 11.16 | | 0.03 | 0.08 | |
| **Medium (M)** | 30.75 | 93.27 | | 1.27 | 3.75 | | 11.82 | 35.84 | | 0.00_NS | 0.02 | |
| **VXM** | 38.74 | 117.50 | | 3.58 | 10.52 | | 13.17 | 39.95 | | 0.02 | 0.06 | |

shoot system (Ratnakumari, 2014). Similarly, Kaur (2002) reported maximum fresh and dry weight of root cluster of *Rosa indica* cuttings was obtained in cocopeat medium.

## Summary and Conclusion

With regard to shoot initiation, the variety Bidhan Marigold 1 recorded the earliest sprouting of cuttings (8.28 days) as compared to Bidhan Marigold 2 (8.33 days). Among the rooting media, the earliest sprouting (7.07 days) was recorded by $M_8$– soil : vermicompost : coco peat :sawdust (1:1:1:1) v/v+ mycorrhiza which was significantly superior to $M_6$–soil : vermicompost : cocopeat : ricehusk (1:1:1:1)v/v + mycorrhiza (7.55 days) and $M_4$ – soil : vermicompost : coco peat (1:1:1) v/v+ mycorrhiza (7.67 days). Maximum delay was observed for sprouting of terminal cuttings planted in $M_1$ – soil. (9.24 days). The other shoot parameters *viz*., number of shoots per cutting, length of longest shoot, number of leaves per cutting, leaf area per cutting, leaf chlorophyll content, fresh and dry weight of shoots and whole plant were found to be significantly influenced by variety and rooting media where the above media were found to show superior performance.

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