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Efficacy of Fabric Bio-Fertilizer on Plant Growth

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ABSTRACT

In the present study, eight treatments (T1, T2, T3, T4, T5, T6, T7, and T8) were taken to study the efficacy of developed fabric bio-fertilizer on plant growth using various potting media components to identify the best suited component and combination for the production. Cotton bio-fertilizer (T3C3) and silk bio-fertilizer (T5S2) application gave highest growth of marigold plant and the lowest growth was achieved in control (T7) and while slightly lower in Farm Yard Manure (FYM) treatment (T8). Hence, it can be concluded that ornamental plants grown using the fabric bio-fertilizer made from discarded cotton and silk fabric had very good growth rate.

Introduction

In today's era, heavy doses of chemical fertilizers and pesticides are being used farmers to get a better yield of various field crops. These chemical fertilizer and pesticide decreased soil fertility and caused health problems to the consumers. Due to adverse effect of chemical fertilizers, interest has been stimulated for the use of organic manures. Dominance of chemical agriculture is last few decades have deteriorated the soil health and created the problem of discarded fabric waste disposal in garment industry, textile mills, manufacturing units, boutiques, tailor shops and household textile sectors. It is important to maintain environmental and agricultural sustainability without reducing productivity. The earth worms have been fortunate to degrade wastes and turn them to bio-fertilizer which is popularly termed as vermicomposting, thus acquired product is recognized as vermicomposting. The earthworms not only convert the organic fractions of urban wastes into available nutrients (Pattnaik and Reddy, 2009) but also consequently remediate the persistent heavy metal toxicants from the substrate by bioaccumulation through vermi-composting process (Suthar, 2008; Pattnaik and Reddy, 2010). Agricultural waste, textile waste, city garbage and kitchen waste has been recycled with vermicomposting along with bio-conversion of organic waste material into nutrition rich vermicompost by earthworm activity (Mall *et al.,* 2005).

Vermicompost is a nutrient-rich microbiologically-active organic amendment which results from the interactions between earthworms and microorganisms in the breakdown of organic matter. It is a stabilized, finely-divided peat-like material with a low C: N ratio and high water-holding capacity that constitutes a source of plant nutrients which are released gradually, through mineralization, as the plant needs them (Domínguez, 2004). Vermicomposts have many outstanding biological properties. They are rich in bacteria, actinomycetes, fungi and cellulose-degrading bacteria. Earthworm castings, obtained after sludge digestion, were rich in microorganisms, especially bacteria. The outstanding physico-chemical and biological properties of vermicomposts makes them excellent materials as additives to greenhouse container media, organic fertilizers or soil amendments for various field horticultural crops. Vermiculture technology has been considered as a sound and viable option to regenerate the soil health through recycling the discarded fabric waste. Nowadays we have a number of methods that are used for waste disposal such as biomethanation, incineration, sanitary land filling etc; but one of the most economically viable methods is vermicomposting. Vermicomposting is an inexpensive process and can be implemented anywhere for solid waste management. The present study chosen considering the fact that management of discarded fabric through Vermicomposting is of paramount significant from the point of view of healthy quality of environment. Hence this work promote the utility of earthworm potential in waste management biotechnology, thus resulted in utilization of waste material into useful product on one side environment clean up another side. In the present study, the efficacy of fabric bio-fertilizer on plant growth was also conducted using various potting media components to identify the best suited component and combination for the production. This innovative idea to overcome environmental hazards of discarded fabrics, a biodegradable product, would like to be protector and preserver of mother earth and further generation and immediate environment will be a much better place to live in. The scope of the research encompasses of benefitting the farmers, industrialists, boutiques and tailors shop owners and to the ecology and future generations to come. The basis of the proposed research "efficacy of fabric bio-fertilizer on plant growth" is to add facts regarding the utilization of discarded fabric in an eco-friendly means with sustainability as focal point.

Materials and Methods

Pot culture study

On the basis of nutrient analysis as well as obtained high rating score evaluated by soil science experts, the best cotton bio-fertilizer and silk bio-fertilizer were used for pot culture study for improving plant growth. Complete Randomized Design (CRD) was used to evaluate the growth and yield of plants. This is done to reduce the variability within the pots compared to variability between the pots. The pots are randomly assigned to the treatment. The experiment was carried out as CRD with three replications and in each replication, three pots were investigated. The different colors represent different treatments (Fig. 1).

The test ornamental plant i.e. African marigold (*Tagetes Erecta*)/Pusa Basanti Gainda belongs to family *Asteraceae* or

Compositae was selected purposively because of shorter life span and also gives best results in small period (Fig. 4). The researcher purchased portrays and 24 medium sized plastic pots of dimension (20 cm height and 22 cm diameter) from local market.

The pots were cleaned and washed in a large tub of cold water, dried in sun and labeled as per the nomenclature followed in the study to grow and compare the plants. To study the efficacy of developed bio-fertilizer on plant growth, potting media raw materials i.e. soil, sand and developed bio-fertilizer were measured in prescribed ratio with the help of weighing balance (Fig. 6). Based upon research studies, soil and sand in the proportion of 4:1 (Soil: Sand) were added in the each potting media and pots filled with soil and sand. Total 24 pots were taken and each pot was filled with 5kg of soil (4 Kg) and sand (1 Kg). The tested nutrient rich cotton bio-fertilizers (T3C3) and nutrient rich silk bio-fertilizers (T5S2) were mixed in soil and sand mixer with appropriate percent (Fig. 7). These soil mixtures were filled in the respective pots and the seedlings were transplanted in it.

Total 24 potting media prepared, in which three potting media (T1,T2,T3) prepared from developed cotton bio-fertilizer T3C3 in the ratio of 4:1:2%, 4:1:3%, 4:1:4% (Soil : Sand : cotton bio-fertilizer) respectively with three replicates, three potting media (T4, T5, T6) prepared from developed silk bio-fertilizer T5S2 in the ratio of 4:1:2%, 4:1:3%, 4:1:4% (Soil : Sand : silk bio-fertilizer) respectively with three replicates, the untreated potting media T7 was considered as control which prepared in the ratio of 4:1 (Soil: Sand : Without bio-fertilizer) with three replicates. Farm Yard Manure (FYM) potting media T8 prepared in the ratio of 4:1:4% (Soil: Sand: FYM) with three replicates (Table 1 and Fig. 7). In this study, Farm Yard Manure (FYM) was used as standard compost because it is one of the oldest manure used by the farmers in growing crops because of its easy availability.

The marigold seedlings were cultured in seedling trays. Healthy, uniform seeds of African marigold were sown on second week of September 2015 in seedling tray. In each cell of seedling tray was filled with soil and sown a seed was done at 1 seed per cell. Regular care was taken to maintain the germination of the seeds by proper watering and maintenance. Seeds were germinated in seedling tray with the same medium for each treatment. The marigold seedlings attained a height of about 7-8 cm in 15 days and they were ready for transplanted in the prepared pots (Fig. 3).

After 15 days healthy and uniform marigold seedlings were transplanted in the 24 potting media (Fig. 8). The seedlings were planted in last week of September is best for their growth. Immediately after transplanting the seedlings were irrigated with tap water as and when required for better establishment of seedlings in the pot and grown-on for 75 days. As per the treatment, equal quantity of irrigation water was given for each pot throughout the experiment using measuring cup. Cultured seedlings were transplanted in to potting media containing 2%, 3%, and 4% of developed bio-fertilizer T3C3 and T5S2. All the bio-fertilizers were applied as pre-plantation manures and no additional manure was added at any stage during the experiment. The bio-fertilizers were mixed thoroughly with soil before planting the saplings. Three replicates were maintained for each potting media. In pot culture experiment, the plant height, shoot length, leaf length, no. of flowers and no. of bud were recorded on 45, 60 and 75 Day After Transplanting (DAT). Regular monitoring was done to protect from insects etc. Necessary plant protection measures were adopted.

Study of plant growth parameters

Parameters like plant height, shoot length, leaf length, no. of flowers and no. of bud etc were recorded on 45, 60, 75 DAT of pot culture experiment. The recorded data were statistically analyzed (ANOVA analysis) using the Statistical Package for Social Sciences (SPSS) software. One plant from each replicate of a pot was analyzed for its various parameters and the average was calculated.

The germination percentage was calculated 15 days after sowing. The protrusion of radical through seed coats was taken as the criterion for germination. A period of 15 days was allowed for all the samples to germinate in the different medium. Researcher prepared 24 potting media of size 20 cm height and 22 cm diameter were used to determine the germination percentage of marigold seeds in each of the 8 treatments. A total of 10 African marigold seeds with spacing of 3cm were sown at a depth of 3cm in the each pot before transplanting seedlings in potting media. After that seeds were allowed to germinate for 15 days. It was checked regularly and was watered regularly. Hence, a total of 240 seeds were sown in 24 pots. Germination percentage was determined in each of the eight treatments after 15 days (Fig. 9).

Average Plant height was recorded at 45, 60, 75 DAT by measuring from the base of plant stem from ground level to the main growing tip in centimeter using a simple ruler (scale) (Fig. 10). The new growth from seed germination that grows upward is a shoot where leaves will develop. Average shoot length was recorded at 45, 60, 75 DAT by measuring from the base of plant stem to the highest length of shoot in centimeter using a simple ruler (scale) (Fig. 11). Total number of flowers and buds from each treatment was counted at 45, 60, 75 DAT and then average was calculated to get number of flowers and buds per plant (Fig. 12). Leaf length is an important part of plant to analyze the growth and predict the yield. In case of the longest leaf measurement, 2 to 3 longest leaves were measured to identify the longest one. Average leaf length was recorded at 45, 60, 75 DAT by measuring from the base of leaf to the highest length of leaf in centimeter using a simple ruler (scale) (Fig. 13). Roots allow a plant to absorb water and nutrients from the surrounding soil and a healthy root system is the key to healthy plant. To observe root length, the soil up to 15 cm depth from ground level was excavated after that soil was removed and roots were washed with clean water then put to remove excess water from root surface and then root length was taken and average data were calculated. Average root length in each treatment was observed after harvesting the plants (75 DAT) using a simple ruler (scale) (Fig. 14).

Results and Discussion

The data on various characters studied during the course of investigation were statistically analyzed. Wherever statistical significance was observed, critical difference (CD) at 0.05 level of probability was worked out for comparison.

Plant growth observations

Germination percentage

A seed starts to grow from the time it begins to germinate. When the seed starts to germinate the main root comes first and then the skin starts to split and later leaves appear. The investigator noted the days when germination started in order to see if the plants were healthy. The pots were irrigated immediately after seed sowing and repeated every day till the final emergence. Germination percentage was determined in each of the eight treatments after 15 DAS see in Table 2. For high productivity, the adequate stand of crop plants largely depend on seed germinability and seeding vigour under a wider range of climatic conditions.

Application of cotton bio-fertilizer

The data pertaining to germination percent of cotton bio-fertilizer and statistical analysis also reveals that, Table 2, there was non-significant difference between T1 Vs T2, T1 Vs T3 and T2 Vs T3. The pot culture study stated that mean germination percent of marigold plant had higher in T3 (90) at a rate of 4% bio-fertilizer dose and lower in T1, T2 (86.66).

Application of silk bio-fertilizer

Based on the observation and results obtained from the study, data presented in Table 2, germination percent of silk bio-fertilizer dose, non-significance difference between T4VsT5, T4VsT6 and T5VsT6. Treatment T6 had higher germination percent (90) as compared to the bio-fertilizer T4 (83.33) and T5 (86.66).

Treatments comparison

At a rate of 4% cotton and silk bio-fertilizer application treatment (T3 and T6) compare with 4% Farm Yard Manure (FYM) application treatment (T8), there was significant difference between T3VsT8, T6VsT8 on 15 DAS and in which mean germination percent was higher in T3 and T6 (Table 2).

The higher percentage of germination was significantly improved by the sole application of bio-fertilizer. This is because of garden soil and cotton and silk bio-fertilizer are high organic matter content which increases the water and nutrients holding capacity of the medium, which improve the water utilization capacity of plant. Developed bio-fertilizer is reported to have bioactive principles which are considered to be beneficial for root growth. It is a clear evidence to support that the bio-fertilizer medium promote and enhanced the germination process of the marigold. Vanmathi and Selvakumari (2012) study stated that the germination percentage was higher in vermicompost treatment when compared to urea and control. On 15 DAS, the germination percentage of *Hibiscus esculentus* in control and experiment 1 and 2 it was noted as 20%, 90%, and 66.6% respectively.

Plant height (cm)

The plant height is the major yield contributing parameter of marigold. Plant height was recorded at 45, 60, 75 DAT of growth by measuring from the base of plant stem from ground level to the main growing tip in centimeter. The plant height increased significantly due to the application of bio-fertilizer. It may be due to more nutrient availability for plant growth in developed bio-fertilizer. In cotton and silk bio-fertilizer treatments revels that plant height increased with the percentage of the bio-fertilizer and days were increase. The plant height increased progressively with advancement in the age of the plant in all the experiment (Table 3).

Application of cotton bio-fertilizer

The data with regards to the height of marigold plant influenced by cotton bio-fertilizer application are presented in Table 3.

It is also evident from the data that on 45, 60 DAT, there was significant difference between T1VsT3 and non-significant difference between T1VsT2, T2VsT3. On 75 DAT, non-significant difference between T1VsT2, T1VsT3 and T2VsT3.Slightly higher mean plant height (45 DAT: 30.06cm, 60 DAT: 37.90cm, 75 DAT: 44.33cm) in T3 at a rate of 4% cotton bio-fertilizer application.

Fig.1 CRD for testing the efficacy of bio-fertilizer on plant growth

T1	T4	T2	T7	T3	T8	T4	T7
T3	T6	T1	T6	T2	T6	T2	T8
T7	T5	T4,	T8	T1	T5	T3	T5

Details of experimental plan

Plant	**Marigold**
Variety	African Marigold *(Tagetes Erecta* L.)
Developed bio-fertilizers used for experiment	T3C3 and T5S2
No. of treatments	8
Number of replication	3
Total no of pots	24
Number of corms planted per pot	1
Size of corm (diameter)	5-6 cm
Depth of planting	7-8 cm
Pot size	20 cm height and 22 cm diameter
Experimental design	Completely Randomized design (CRD)
Culture of seedlings	15 days (09^{th} Sep. to 23^{rd} Sep. 2015)
Record Germination %	23^{rd} Sep. 2015
Transplanting of seedlings	24^{th} September 2015
Duration of experiment	75 days (24^{th} September to 07^{th} December 2015)
Record plant growth parameters	45,60 and 75 DAT
Ratio of soil and sand	4:1 (4Kgs +1 Kg) = 5 Kg (5000 gm)
% of bio-fertilizer	
T3C3 doze	2% (100 gm),3% (150 gm), 4%(200 gm)
T5S2 doze	2% (100 gm),3% (150 gm), 4%(200 gm)
T7 without bio-fertilizer	Control
T8 (FYM)	4% (200 gm)

Fig.2: Experimental Site

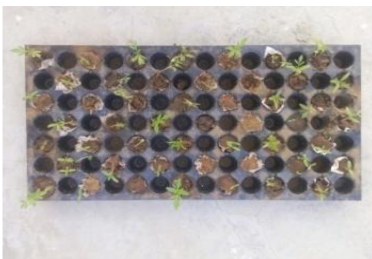

Fig.3: Culture of seedlings

Fig.4: Marigold seeds used for plant growth

Fig.5: Weighing of bio-fertilizer

Soil

Sand

Mixing of sand and soil

Potting Media mixer

Fig.6: Potting media raw materials

Filling of pot

Prepared Potting media

Watering of potting

Fig.7: Preparation of potting media

Fig.8: Transplanting of seedlings

Fig.9: Calculate germination percenta

Fig.10: Record plant height

Fig.11: Record shoots length

ig.12: Record number of flowers and buds

Fig.13: Record leaf length

Fig.14: Record root length

Fig.15 Effect of bio-fertilizer on plant growth of marigold

Table.1 Potting media ratio

Bio-fertilizer	Treatments	Repli-cation	Ratio of Soil and Sand	% of bio-fertilizer dose	Water/plant/day
T3C3	T1	3	4:1 (4Kgs +1 Kg)=5 Kg (5000 gm)	2% (100 gm)	100 ml.
	T2	3	4:1 (4Kgs+1 Kg) =5 Kg (5000 gm)	3% (150 gm)	100 ml.
	T3	3	4:1 (4Kgs+1 Kg) =5 Kg (5000 gm)	4% (200 gm)	100 ml.
T5S2	T4	3	4:1 (4Kgs+1 Kg) =5 Kg (5000 gm)	2% (100 gm)	100 ml.
	T5	3	4:1 (4Kgs+1 Kg) =5 Kg (5000 gm)	3% (150 gm)	100 ml.
	T6	3	4:1 (4Kgs+1 Kg) =5 Kg (5000 gm)	4% (200 gm)	100 ml.
Control	T7	3	4:1 (4Kgs+1 Kg) =5 Kg (5000 gm)	-	100 ml.
FYM	T8	3	4:1 (4Kgs+1 Kg) =5 Kg (5000 gm)	4% (200 gm)	100 ml.

Table.2 Mean germination % of marigold plant growth treatments

Treatments		15 Day After Sowing (DAS)	
		Mean (%)	SD
Cotton Bio-fertilizer	T1 (2%)	86.66	5.77
	T2 (3%)	86.66	5.77
	T3 (4%)	90.00	0.00
Silk Bio-fertilizer	T4 (2%)	83.33	5.77
	T5 (3%)	86.66	5.77
	T6 (4%)	90.00	0.00
Control	T7	76.66	5.77
FYM	T8 (4%)	80.00	0.00
	GM	85.00	5.89
	S.Em.	2.63	
	CD (P=0.05)	7.90	

Table.3 Mean height of marigold plant growth treatments

Treatments		45 DAT		60 DAT		75 DAT	
		Mean(cm)	SD	Mean(cm)	SD	Mean(cm)	SD
T3C3	T1 (2%)	28.96	0.20	36.90	0.87	43.86	0.40
	T2 (3%)	29.56	0.57	37.30	0.45	43.96	0.72
	T3 (4%)	30.06	0.15	37.90	0.10	44.33	0.57
T5S2	T4 (2%)	28.80	0.26	36.53	0.75	43.60	0.09
	T5 (3%)	29.00	0.00	36.80	0.10	43.96	0.55
	T6 (4%)	29.46	0.45	36.96	0.05	44.20	0.34
Control	T7	23.13	0.25	32.53	0.40	37.43	0.49
FYM	T8 (4%)	25.60	0.72	33.06	0.11	39.66	0.66
	GM	28.07	2.33	36.00	1.97	42.62	2.51
	S.Em.	0.22		0.26		0.29	
	CD (P=0.05)	0.68		0.80		0.89	

DAT-Day After Transplanting

Table.4 Mean shoot length of marigold plant growth treatments

Treatments		45 DAT		60 DAT		75 DAT	
		Mean(cm)	**SD**	**Mean(cm)**	**SD**	**Mean(cm)**	**SD**
T3C3	T1 (2%)	24.60	0.36	33.30	0.51	39.90	0.43
	T2 (3%)	24.90	0.10	33.36	0.49	40.00	0.69
	T3 (4%)	25.23	0.15	33.93	0.05	40.36	0.55
T5S2	T4 (2%)	24.70	0.10	33.00	0.69	39.66	0.11
	T5 (3%)	25.03	0.05	33.16	0.55	40.00	0.55
	T6 (4%)	25.60	0.51	33.40	0.45	40.26	0.46
Control	T7	18.46	0.40	28.50	0.45	33.40	0.52
FYM	T8 (4%)	22.16	0.20	30.10	0.17	35.60	0.62
	GM	23.83	2.31	32.34	1.90	38.65	2.55
	S.Em.	0.16		0.27		0.30	
	CD (P=0.05)	0.49		0.80		0.90	

DAT-Day After Transplanting

Table.5 Mean leaf length of marigold plant growth treatments

Treatments		45 DAT		60 DAT		75 DAT	
		Mean(cm)	**SD**	**Mean(cm)**	**SD**	**Mean(cm)**	**SD**
T3C3	T1 (2%)	7.10	0.20	9.13	0.23	11.90	0.09
	T2 (3%)	7.20	0.26	9.23	0.15	12.30	0.34
	T3 (4%)	7.33	0.28	9.33	0.11	12.66	0.20
T5S2	T4 (2%)	7.16	0.20	9.30	0.10	12.00	0.10
	T5 (3%)	7.50	0.10	9.40	0.34	12.26	0.30
	T6 (4%)	7.60	0.17	9.56	0.49	12.56	0.20
Control	T7	4.73	0.94	6.63	0.25	8.30	0.26
FYM	T8 (4%)	5.36	0.63	7.66	0.20	9.23	0.40
	GM	6.75	1.09	8.78	1.03	11.40	1.60
	S.Em.	0.25		0.15		0.15	
	CD (P=0.05)	0.76		0.46		0.45	

DAT-Day After Transplanting

Table.6 Mean number of flower buds of marigold plant growth treatments

Treatments		45 DAT		60 DAT		75 DAT	
		Mean(cm)	**SD**	**Mean(cm)**	**SD**	**Mean(cm)**	**SD**
T3C3	T1 (2%)	2.33	0.57	5.33	0.57	9.33	0.57
	T2 (3%)	2.66	0.57	5.66	0.57	9.66	0.57
	T3 (4%)	3.00	0.0	6.00	0.00	10.00	0.00
T5S2	T4 (2%)	2.00	0.00	5.33	2.08	9.00	0.00
	T5 (3%)	2.33	0.57	5.00	0.00	9.33	0.57
	T6 (4%)	2.66	0.57	5.33	0.57	9.66	0.57
Control	T7	0.66	0.57	2.33	0.57	5.00	1.00
FYM	T8 (4%)	1.66	0.57	3.33	0.57	7.00	0.00
	GM	2.16	0.81	4.79	1.41	8.62	1.71
	S.Em.	0.28		0.50		0.31	
	CD	0.86		1.49		0.93	

DAT-Day After Transplanting

Table.7 Mean number of flowers of marigold plant growth treatments

Treatments		45 DAT		60 DAT		75 DAT	
		Mean(cm)	**SD**	**Mean(cm)**	**SD**	**Mean(cm)**	**SD**
T3C3	T1 (2%)	2.33	0.57	4.33	0.57	10.66	0.57
	T2 (3%)	2.33	0.57	4.66	0.57	11.33	0.57
	T3 (4%)	2.66	0.57	5.00	0.00	11.66	0.57
T5S2	T4 (2%)	2.33	0.57	4.66	0.57	11.00	0.00
	T5 (3%)	2.66	0.57	5.00	0.00	11.33	0.57
	T6 (4%)	3.00	0.00	5.33	0.57	11.6	0.57
Control	T7	1.00	1.00	2.33	0.57	7.00	1.00
FYM	T8 (4%)	1.66	0.57	3.00	0.00	8.66	0.57
	GM	2.25	0.79	4.29	1.08	10.41	1.69
	S.Em.	0.35		0.26		0.35	
	CD	1.05		0.79		1.05	

DAT-Day After Transplanting

Table.8 Mean root length of marigold plant growth treatments

Treatments		75 DAT	
		Mean (cm)	**SD**
Cotton Bio-fertilizer	T1 (2%)	19.10	0.09
	T2 (3%)	19.30	0.26
	T3 (4%)	19.90	0.40
Silk Bio-fertilizer	T4 (2%)	19.23	0.15
	T5 (3%)	19.60	0.26
	T6 (4%)	19.76	0.23
Control	T7	15.10	0.10
FYM	T8 (4%)	17.26	0.15
	GM	18.65	1.59
	S.Em.	0.13	
	CD (P=0.05)	0.39	

DAT-Day After Transplanting

Application of silk bio-fertilizer

The data also clearly indicated that 45, 60, 75 DAT there was non-significant difference between T4VsT5, T4VsT6 and T5VsT6. Similarly, slightly higher plant height (45 DAT: 29.46cm, 60 DAT: 36.96cm, 75 DAT: 44.20cm) was observed in treatment T6, at a rate of 4% silk bio-fertilizer (Table 3).

Treatments comparison

4% cotton and silk bio-fertilizer application (T3,T6) compare with 4% FYM application treatment (T8),there was significant difference between T3VsT8, T6VsT8 on 45, 60, 75 DAT and in which, higher plant height observed in T3 and T6 and lower in T8 (Table 3).

The amount of vermicompost had a significant effect on not only growth and flowering of the Marigold plants, but also on the plant shoot and root biomass, plant height and diameter of the flowers (Pritam *et al.*, 2010). Pot culture study result showed that increases plant height at a rate of 4% cotton and silk bio-fertilizer application media, increased yield and improved nitrogen and phosphorus uptake.

Shoot length (cm)

Application of cotton bio-fertilizer

The data related to effect of cotton bio-fertilizer on shoot length of marigold plant have been presented in Table 4. Data recorded on 45DAT, 60DAT, 75 DAT, there was non-significant difference between T1VsT2, T1VsT3 and T2VsT3. Slightly higher mean plant height (45DAT: 25.23 cm, 60DAT: 33.93cm, 75DAT: 40.36cm) in T3 at a rate of 4% cotton bio-fertilizer application.

Application of silk bio-fertilizer

It is evident from the data that on 45DAT, significant difference between T4VsT6, T5VsT6 and non-significant difference between T4VsT5.

On 60DAT, 75DAT, non-significant difference between T4VsT5, T4VsT6, T5VsT6. Similarly, slightly higher shoot length (45DAT: 25.60cm, 60DAT:33.40cm, 75DAT:40.26cm) was observed in treatment T6, at a rate of 4% silk bio-fertilizer application (Table 4).

Treatments comparison

4% cotton and silk bio-fertilizer application treatments (T3, T6) compare with 4% FYM application treatment (T8), there was significant difference between T3VsT8, T6VsT8 on 45DAT, 60DAT, 75 DAT and in which, higher shoot length observed in T3 and T6 and slightly lower in T8. Higher shoot length recorded in T3 and T6 treatments due to developed bio-fertilizer has a high special area which provides large porosity for better retention of water and nutrients and activity of microorganisms (Table 4).

Leaf length (cm)

Application of cotton bio-fertilizer

A bird eye view of the data revels that on 45DAT, 60 DAT, non-significant difference between T1VsT2, T1VsT3 and T2VsT3.On 75DAT significant difference between T1VsT3 and non-significant difference between T1VsT2, T2VsT3. Slightly higher mean leaf length (45DAT:7.33 cm, 60DAT:9.33cm, 75DAT:12.66cm) in T3 at a rate of 4% cotton bio-fertilizer application (Table 5).

Application of silk bio-fertilizer

A keen observation of the data revels that on 45DAT, 60DAT, non-significant difference between T4VsT5, T4VsT6, and T5VsT6.

On 75 DAT, significant difference between T4VsT6 and non-significant difference between T4VsT5 and T5VsT6. Slightly higher leaf length (45DAT: 7.60cm, 60DAT:9.56cm, 75DAT:12.56cm) was observed in treatment T6, at a rate of 4% silk bio-fertilizer application (Table 5).

Treatments comparison

4% cotton and silk bio-fertilizer application treatments (T3, T6) compare with 4% FYM application treatment (T8), there was significant difference between T3VsT8, T6VsT8 on 45, 60, 75 DAT and in which, higher leaf length observed in T3 and T6 and lower in T8 (Table 5).

Number of flower buds

Number of flower bud / plant from each treatment was counted and then mean was calculated to get number of bud per plant. Total number of buds and flowers in each treatment was counted and recorded.

Application of cotton bio-fertilizer

The data related to effect of cotton bio-fertilizer on number of flower buds have been presented in Table 6. Data recorded on 45DAT, 60DAT, 75 DAT, non-significant difference between T1VsT2, T1VsT3 and T2VsT3. Slightly higher mean number of flower buds(45DAT: 3 no., 60DAT:6 no., 75DAT:10 no.) in T3 at a rate of 4% cotton bio-fertilizer application.

Application of silk bio-fertilizer

An appraisal of the data presented in Table 6 clearly reveals that on 45DAT, 60DAT, 75 DAT, non-significant difference between T4VsT5,T4VsT6,T5VsT6. Slightly higher mean number of flower buds (45DAT:2.66 no., 60DAT:5.33 no., 75DAT:9.66 no.) was observed in treatment T6, at a rate of 4% silk bio-fertilizer application.

Treatments comparison

4% cotton and silk bio-fertilizer application treatments (T3, T6) compare with 4% FYM application treatment (T8), there was significant difference between T3VsT8, T6VsT8 on 45DAT, 60DAT, 75DAT and in which, higher number of flower buds observed in T3 and T6 and lower in T8.

Number of flowers

Number of open flowers / plant from each treatment was counted and then mean was calculated to get number of flower per plant. Total number of flowers in each treatment was counted and recorded.

Application of cotton Bio-fertilizer

A perusal of the data soundly proved that on 45DAT, 60DAT, 75DAT, non-significant difference between T1VsT2, T1VsT3 and T2VsT3. Slightly higher mean number of flowers (45DAT: 2.66 no., 60DAT: 5 no., 75DAT:11.66 no.) in T3 at a rate of 4% cotton bio-fertilizer application (Table 7).

Application of silk bio-fertilizer

The data pertaining to number of flower on 45DAT, 60DAT, 75 DAT, non-significant difference between T4VsT5, T4VsT6, T5VsT6. Slightly higher mean number of flower buds (45DAT:3 no., 60DAT:5.33 no., 75DAT:11.66 no.) was observed in treatment T6, at a rate of 4% silk bio-fertilizer application (Table 7).

Treatments comparison

4% cotton and silk bio-fertilizer application treatments (T3, T6) compare with 4% FYM application treatment (T8), there was significant difference between T3VsT8, T6VsT8 on 45DAT, 60DAT, 75 DAT and in which, higher number of flowers observed in T3 and T6 and lower in T8 (Table 7).

It was also reported that soil amended with 4% cotton and silk bio-fertilizer produced the most flowers on the Marigold. A keen observation of the data reveals that the number of flowers per pot was significantly increased due to increase the quantity of developed bio-fertilizer (2%, 3% and 4%). The data revels that higher concentrations of developed bio-fertilizer had higher number of flower per pot.

The best treatment was with the application of 4% cotton and silk bio-fertilizer, which augmented the flowering and yield characters. Developed cotton and silk bio-fertilizer prepared by vermicomposting process. The beneficial effect of earth worms on plant growth may be due to the presence of macro as well as micronutrients in vermicasts and in their secretions in considerable quantities. It is also the effect of metabolites produced by the earth worms which are responsible for stimulating the plant growth. It is also believed that the earth worm release certain vitamins and similar substances into the soil which may be vitamins B or some pro-vitamins D or free amino acids in marigold. Application of organic sources improved the quality parameters. This may be due to improvement in soil physical properties like bulk density, hardness, porosity, soil pH, Hormone etc., and biological properties like bacteria, fungi, actinomycetes and earth worm activity etc. improvement in soil properties might have improved the root growth, nutrient uptake and quality of marigold flowers as reported by Gaur *et al.*, (2006).

Root Length (cm)

Application of cotton bio-fertilizer

The pot culture study stated that, data recorded on 75 DAT (harvesting time), non-significant difference between T1VsT2 and significant difference between T1VsT3 and T2VsT3. Slightly higher mean root length(19.90 cm) in T3 at a rate of 4% cotton bio-fertilizer application (Table 8).

Application of silk bio-fertilizer

On 75 DAT, significant difference between T4VsT6 and non-significant difference between T4VsT5, T5VsT6. Slightly higher mean root length (19.76 cm) was observed in treatment T6, at a rate of 4% silk bio-fertilizer application (Table 8).

Treatments comparison

4% cotton and silk bio-fertilizer application treatments (T3, T6) compare with 4% FYM application treatment (T8), there was significant difference between T3VsT8, T6VsT8 on 75 DAT and in which, higher root length observed in T3 and T6 and lower in T8 (Table 8).

The results portray a fact that bio-fertilizer made from the discarded cotton and silk are a very good source of all the nutrients. Different level (2%, 3%, and 4%) of cotton bio-fertilizer (T1, T2, T3) and silk bio-fertilizer (T4, T5, T6) application, growth parameters had increase as compared to FYM treatment (T8). Cotton and silk bio-fertilizer application gave highest growth of marigold plant and the lowest yield and growth was achieved in control treatment and while slightly lower in FYM. The reason for the highest value in the best treatment (T3, T6) could be due to higher quantity (4%) cotton and silk bio-fertilizer application respectively. Developed bio-fertilizer owing to its surplus nutritive content enhanced beneficial soil micro flora and increase the plant growth. Hence it can be used as best source of organic nutrients for flower productivity as reported by Mittal (2010).

When supplemented to the plants with short life span they had a remarkable difference on the overall growth of the plants viz., root length, shoot length, leaf length. From the pot experiment, it was found that in cotton and silk bio-fertilizer, 2-4% dose of bio-fertilizer in soil and bio-fertilizer mixture resulted higher growth, yield and quality of marigold plant (Fig. 15).

It was concluded that addition of cotton and silk bio-fertilizer, in appropriate quantities, to potting media has synergistic effects on growth and yield of marigold. The obtained results suggest that the impact of bio-fertilizer application on the plant height, root length, shoot length, leaf length, number of flower and bud depended on the bio-fertilizer application dose and on the date of application. The plants grown using the bio-fertilizer made from discarded cotton and silk fabric had very good growth rate compared to the FYM.

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