Original Research Article

Studies on vermicomposting of sericultural wastes: an eco-friendly approach for effective management of seri-wastes

ABSTRACT

Vermicompost is one of the most essential and efficient organic manure commonly applied to the mulberry field in most the advance sericulture countries. Vermicompost is the one of the beneficial biotechnology is the bioconversion of organic waste into useful form. In the current experiment, soil treated with vermicompost of three different treatments viz., Cow dung + Seri-waste (T-1), Cow dung +Seri-waste (T-2) and Cow dung +Seri-waste + Rice straw (T-3) were recorded different parameters. After the application of different treatment of vermicompost the best recorded treatment as a T-as 6.7 pH. The moisture retention capacity was recorded as 52% in T-1 and 74% and 62% respectively in T-2 and T-3, with electric conductivity as 2-3ms/cm. The soil texture of soil treated with T-2 (Cow dung +Seri-waste) showed best input as 50% as compared to T-1 and least in T-3 as 40% and 35% respectively. Application of different treatment of vermicompost on soil recorded to be T-2 (Cow dung +Seri-waste) showed positive response and high availability of microorganisms that are beneficial for the mulberry plant. The germination percentage of seed of mulberry treated with different treatment was recorded to be highest of 90% in T-2 and root and shoot length of plant grown as 26cm and 12cm as compared to T-1 and T-3 as 19 cm and 8cm, 34cm and 10cm respectively. Similarly, the moisture percentage and moisture retention capacity of T-2 was recorded to be highest as 74.64% and 73.21% respectively. Therefore, the current experiment opens new avenues vermicompost substrate for promoting of by-product utilization seri-waste in sericulture. The resultant product could be utilized for agricultural and horticultural as well. The present results offer numerous scopes for further sustainable agriculture with special emphasis on sericulture industry.

KEY WORDS: vermicompost, cow dung, rice straw, seri-waste, soil, nutrient, by-product

INTRODUCTION

Sericulture is the unique combination of traditional agronomic practices for rearing of silk producing Lepidopteran larvae *Bombyx mori* L. on the only soul food material comprising of mulberry leaves. Therefore, in order to insure good quality cocoon yield it's important to pay attention for the development of host plant mulberry. As mulberry account 36 to 38%of the overall practices responsible for successful sericulture. Moreover, the 60percent of the cost of cocoon goes directly to the mulberry leaf [1]. Plant breeders are continuously working for improving the quantitative and qualitative parameters of mulberry for enhancing the output of sericulture in term of cocooning. For realizing full potential of any mulberry

genotypes improvement of the soil health could be done by application of various types of fertilizers doses to increase the productivity. The current era emphasizes the utilization of organic manure for sustainable agriculture. Vermicompost is one of the most essential and efficient organic manure commonly applied to the mulberry field in most the advance sericulture. Jammu and Kashmir being one of the traditional sericulture states holds the responsibility for production of bivoltine silk of international grade. Therefore, the moriculture practices in Jammu and Kashmir particularly in Poonch district demand the emphasis on application of vermicompost for improving the quality and yield parameters of mulberry leaves.

It is a biological process involving stabilization and reduction in volume of organic sludge moderate temperature between 25ºC and 40ºC involving joint action of earthworm active at 10-32ºC and microbes for the transformation of organic wastes into human useful end product [2]. In other words, vermicomposting is a biotechnological process, eco-friendly, pollution free technology and has enormous scope in the recycling of sericulture waste (larva litter, left over mulberry leaves during worm feeding and other waste) into valuable end product. Vermicomposting increase soil fertility, no adverse effects on plant, improving mulberry leaf quality and quantity and also improve soil aeration etc. [3].Therefore, keeping in view the significance of vermicompost in mulberry cultivation by sustainable management of seri-wastes the current experiment entitled “Studies on vermicomposting of sericultural wastes: an eco-friendly approach for effective management of seri-wastes” has been designed with the following objectives; Quality assessment of vermi-composts generated through bioconversion of seri-wastes and Impact of vermicompost on soil and mulberry plant health.

MATERIALS AND METHODS

In the current era of science and technology there is a growing awareness and inclination of farmers towards organic farming with least dependency on synthetic fertilizers. Mulberry cultivation can be made sustainable and economical by recycling all the organic wastes of sericultural origin including rearing waste and mulberry garden residue for production of compost and vermicompost. The current experiment was conducted at Post Graduate Department of Sericulture, Poonch campus, University of Jammu in collaboration with KVK (Krishi Vigyan Kendra), (SKUAST-J), Maize Breeding Station, Poonch (J&K) during the year 2022 with following treatments:

T-1: COWDUNG + RICE STRAW

T-2: COWDUNG + SERI-WASTE

T-3: COWDUNG + RICE STRAW + SERI-WASTE

For the current experiment, earthworm specie namely *Eisenia fetida* was procured from KVK (SKUAST-J), Maize Breeding Station, Poonch (J&K) for preparation of vermicompost. The data generated on various parameters of soil and plant health was subjected to analysis of variance on SPSS software.

RESULTS AND DISCUSSION

I. Nutrient profile of different treatment

Vermicompost being organically rich source of all the available nutrients possess direct influence on the crop plant growing in the soil treated with vermicompost. Moreover, vermicompost accelerate the concentration of nutrient available in the soil making it a suitable growth promoter for plants. Vermicompost products contain numerous nutrients such as nitrogen, potassium, magnesium, manganese, copper, Vitamin, growth hormones and enzymes derived from the decomposed organic matter as reported by Aracin *et al.,* [4]. In the current, experiment total nitrogen,potassiumand phosphorous (NPK) content was analyzed along with micronutrients likeCalcium, magnesium, iron, manganese, zinc and copper for all the treatments. In addition to nutrient content total Carbon: Nitrogen (C:N) ratio was also determined for different sample. The result pertaining to availablenitrogen percentwas recorded to highest in case of Treatment- 2 i.e. Cow dung +Seri-waste as 86% followed by Treatment-3i.e mixture of Cow dung + Seri-waste + Rice straw as 8.0% and least in case of Treatment-1 i.e. Cow dung +Rice straw as 8.2% as given in Table-01. Similarly, the total available phosphorus was recorded to be highest in T-2 followed by T-3 and T-1 as 1.3, 1.60 and 1.4% respectively (Table-01). The total available potassium was recorded to be highest in T-2 followed by T-3 and T-1 as 15.8, 14.2 and 9.6%.The total available calcium was recorded to be highest in T-2 followed by T-3 and T-1 as 4.2, 3.46 and 2.4 ppm.The reason attributed for improved nutrients profile of vermicompost sample obtained from T-2 was the presence of nitrogenous excretal waste of the silkworm larva. Hence, imparting high value of NPK values for organic manure obtained from waste of sericulture origin. Moreover, Aracon *et al.,* [4] and Parthasarathi *et al.,* [5] indicated the high nutrient profile of compost originated from silkworm litter. Thus, the current results were found in significant validation with the reports of Huang *et al.,* [6] and Emperor and Kumar [7].

The total available magnesium was recorded to be highest in T-2 followed by T-3 and T-1 as 2.65, 1.75 and 1.8ppm. Micro-nutrients was recorded with the total available iron was recorded to be highest in T-2 followed by T-3 and T-1 as 3.91, 2.24 and 1.78ppm.The total available manganese was recorded to be highest in T-2 followed by T-3 and T-1 as 6.23, 4.10 and 3.49 ppm. The total available zinc was recorded to be highest in T-2 followed by T-3 and T-1as 5.4, 4.4 and 2.6ppm. The total available copper was recorded to be highest in T-2 followed by T-3 and T-1 as, 3.34, 1.76 and 1.04 ppm (Table-01). Nada *et al.,* [8] reported the variations in micro and micro nutrients values in different vermicompost samples obtained form same substrate material and attributed the reason for variation due to the change in concentration of various enzymes responsible for breakdown of cellulose and lignin material of the plants and animals remains. Moreover, Banik *et al.,* [9], Singh A, Singh, G. S. [10] and Barlas *et al.,* [11] reported the total nitrogen as (0.71-2.39%), soluble phosphorus (0.33-2.6%), soluble potassium (1.14-3.65%) and calcium. (3.51-22.8 ppm), magnesium (0.61-6.64 ppm), iron (7.9-11.5ppm), manganese (2.75-3.43 ppm) and copper (0.89 – 9.83 ppm) for vermicompost sample derived from sericulture waste. The total available carbon: Nitrogen ratio was recorded to be highest in T-2 followed by T-3 and T-1 as

19.46, 17.64 and 14.11ppm.The most ideal value of C:N ratio was recorded for T-2 (Cowdung + Seri-waste) as 19.46%which indicated the superiority of sericultural waste. Manyuchi *et al.,* [12], Gonzalez *et al.,* [13] and Danesh *et al.,* [14] also reported the best most appropriate C: N ratio of 16:20%for organic compost.

Table-01: Nutrient profile of different treatment as Cow dung + Rice straw (T-1), Cow dung + Seri-waste (T-2) and Cow dung + Rice straw + Seri-waste (T-3).

S. no.	Nutrients	Cow dung +Rice straw	Cow dung + Seri-waste	Cow dung + Seri-waste + Rice straw
1)	Nitrogen %	8.2	8.6	8.0
2)	Phosphorus%	1.3	1.60	1.4
3)	Potassium%	9.6	15.8	14.2
4)	Calcium (ppm)	2.4	4.2	3.46
5)	Magnesium(ppm)	1.8	2.63	1.72
6)	Iron(ppm)	1.78	3.91	2.24
7)	Manganese(ppm)	4.10	6.23	3.49
8)	Copper (ppm)	1.04	3.34	1.76
9)	Zinc (ppm)	2.6	5.4	4.4
10)	C:N ratio	14:11	19:46	17:64
MEAN		**4.693**	**7.1170**	**4.693**
S.D				**4.4317**
S.E				**1.401**

II. Impact of different treatments (T-1, T-2 & T-3) on soil health i.e. criteria for comparison

a) pH balancing

For the studied samples, the pH value was observed to be slightly acid with a pH of 6.7 in case of T-2 followed by T-3 as 8.8 and highly alkaline value of pH was recorded in T-1 (Cow dung +Rice straw) as 9.1. Therefore, indicated the suitability of Cow dung + Seri-waste as vermicompost substrate for obtaining sufficiently nutrients rich manure with best suited pH for mulberry plant (Table-02& Fig. 01). Nada *et al.,* [8] reported the acidic + neutral pH in the range of 6-7 for the manure derived from seri-waste, which indicated the validity of current results. Muhammad *et at.,* [15] also reported the most appropriate values of N,P,K with slightly acidic PH of 6.2 for the compost derived from silkworm litter and mulberry twigs. Dominguez and Edwards [16] reported the pH value for different organic manure to

fluctuating from 5.5 to 7.0 until it was almost neutral on the 60 to 120th day when the compost completely ready and reported the reason for in pH range to the production of Co_2 and other organic acid liberated during the microbial metabolism. Moreover, Singh, J [17], Gonzadez, J [18), Pagaria, P. and Totwat, K. L. [19], Suthar [20].Pandya and Yadav [21], Mane and Raskar [22] and Okwor *et al.,*[23] who attributed microbial decomposition of organic matter during vermicompost which lives to production of organic acids which shift the pH near to neutral.

b) Electric conductivity (EC)

Results obtained from the current experiment showed higher EC of T-2 sample comprising of Cow dung + Seri-waste as 2-3ms/cm followed by T-3 (Cow dung + Seri-waste + Rice straw) as 1-3 ms/cm and least in case of T-1 (Cow dung +Rice straw) as 4-6ms/cm.As the best results pertaining to electric conductivity was again obtained from T-2 (Cow dung + Seri-waste) with value of 2-3 ms/cm, indicated the superiority of Seri-waste over the other treatments (Table-02& Fig. 01). Noth *et al.,* [24] reported the best range of the EC as 2-3 ms/cmfor sericulture waste which confirms the validity of current results.

c) Moisture retention Capacity (MRC) and soil texture

The soil provided with vermicompost was evaluated for moisture retention percentage and the results were found to be significantly higher in T- 2 (Cow dung + Seri-waste) soil sample as 74% (Table-02) followed by T-3 (Cow dung + Rice straw+ Seri-waste) as 6.2 %and least T-1 (Cow dung+ Rice straw) as 52% as shown in Fig. 01.The results pertaining to soil texture depicted the increased concentration of organic matter (Fig. 02) up to 50% and clay particles up to 30% in T-2 (Cow dung + Seri-waste)(Table-03). The results thus presented the improvement of soil texture when treated with vermicompost. The most ideal value of the MRC of the soil as 74%with most suitable soil aggregation proportion of clay particles to be particles as 30%belong from sericultural origin as reported to be most ideal for crop cultivation as suggested by earlier reports of Ceritoglu *et al.,* [25], Pathma, J and Sakthivel, N. [26] and Lin *et al.,* [27].

Table no-02: pH value, electric conductivity and moisture retention capacity of soil treated with different types of vermicompost material.

S no.	Treatment	PH	Electric conductivity (ms/cm)	Moisture retention capacity (%)
1)	**Cow dung + Rice-straw (T-1)**	6.7	4-6	52
2)	**Cow dung + Seri waste (T-2)**	8.8	2-3	74
3)	**Cow dung + Seri-waste + Rice straw (T-3)**	9.1	1-3	62

MEAN	**8.2**	**2.3**	**62.66**
S.D	**1.307**	**1.527**	**1.307**
S.E	**.754**	**.881**	**.751**

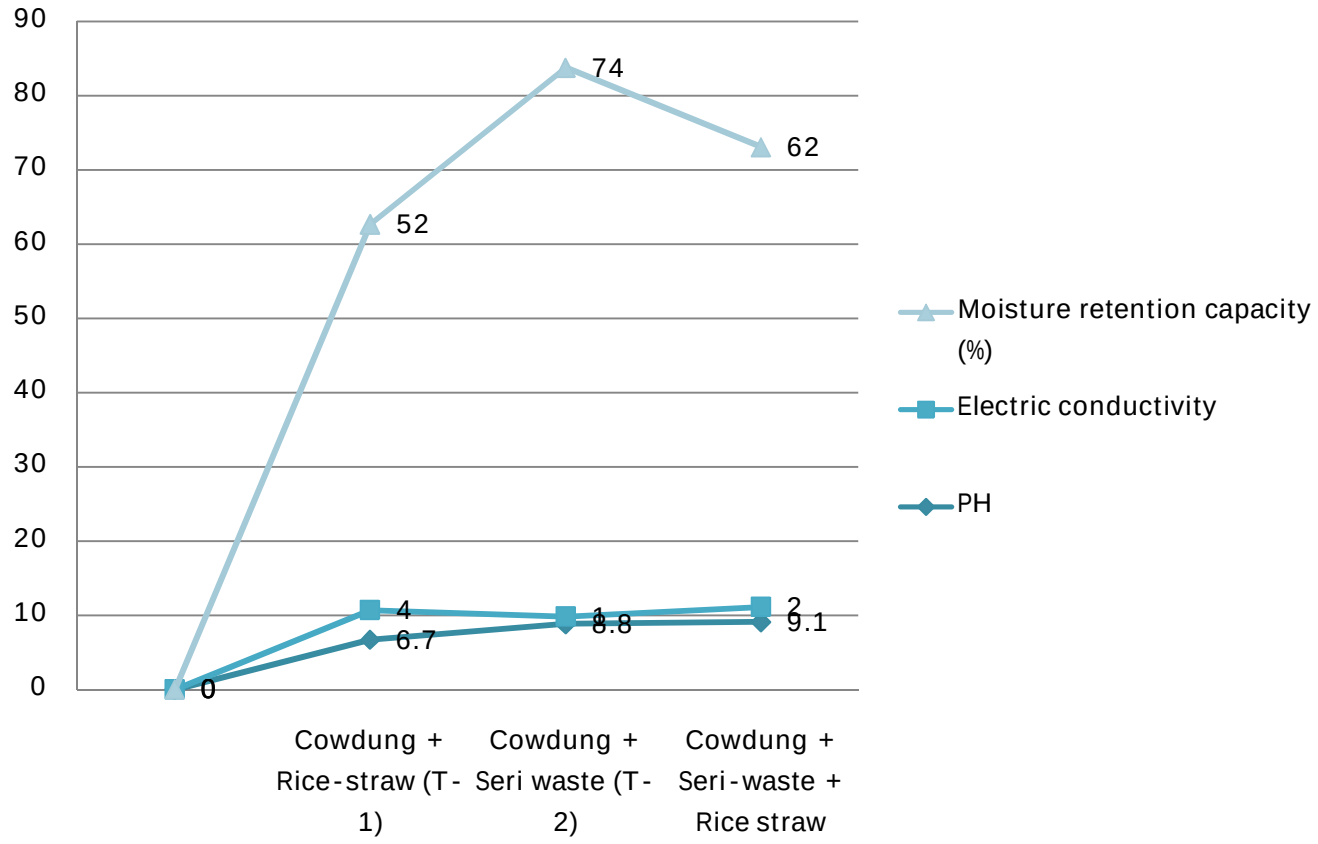

Fig.-01: pH value, electric conductivity and moisture retention capacity of soil treated with different types of vermicompost material.

Table no-03: Relative proportion of soil aggregates in soil samples treated with different combinations of vermicompost

S. no	Treatment	Soil texture

		Sand (%)	Slit (%)	Clay (%)	Soil organic (%)
1	**Cowdung + Rice straw (T-1)**	30	10	20	40
2	**Cow dung + Seri waste (T-2)**	10	10	30	50
3	**Cowdung +Rice straw + Seri-waste (T-3)**	30	15	20	35
4	**Untreated soil sample**	40	20	10	30
MEAN		**38.75**	**13.17**	**27.50**	**38.75**
S.D		**12.58**	**4.787**	**3.535**	**8.539**
S.E		**6.29**	**2.935**	**1.767**	**2.795**

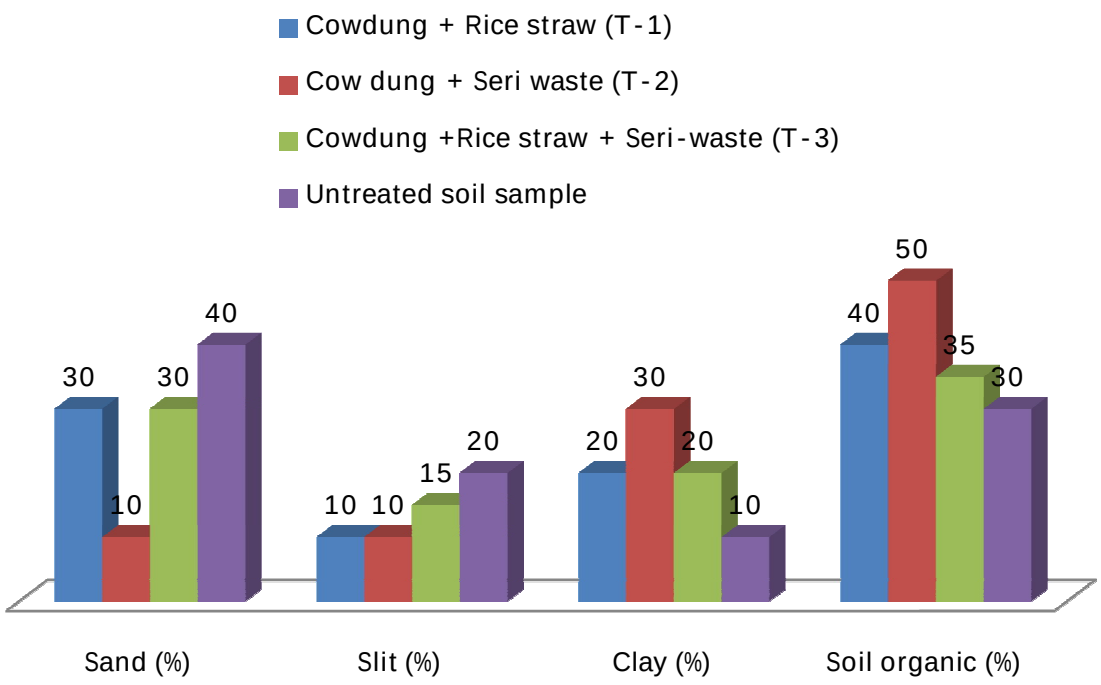

Fig.-02: Relative proportion of soil aggregates in soil samples treated with different combinations of vermicompost

d) Growth of beneficial bacteria and fungi in the soil

In the current experiment, the vermicompost samples of all the treatments i.eT-1, T-2 and T-3 were evaluated for the presence or absence of different types of microorganisms developing in it. The results were recorded for the presence of *Azotobacter chrococcum* and *Azospirilum lipoferium* in all the treatments. Moreover, the treatment T-3 of (Cow dung+ Rice straw + Seri-waste) was recorded with highest number of bacterial inoculation as of 18 in number per 50gm of the sample followed by T-2 (Cow dung +Seri-waste) i.e. 20 in number per 50gm and T-1 as 13 in number per 50gm of the vermicompost sample. In addition, various other microorganisms and insects were observed enlisted in Table no.4.The results of the current experiment lies in close affirmation with that of Sinha *et al.,*[28] that utilized livestock manure as a substrate for the production of vermicompost and recorded the product with higher microbial population compared to municipal waste.

Table no-04: Detail of Microorganisms recorded from different samples of vermicompost.

S. no.	Treatment (T)	Name of the insects Microorganisms and number		Total number of insects in 50g Samples
1	Cow dung + Rice straw (T-1)	**Name**	**No.**	13
		a) Weevil	4	
		b) Ants	6	
		c) Sow bugs	3	
2	Cow dung + Seri- waste (T-2)	a) Little white bugs	7	20
		b) Sow bugs	5	
		c) Ants	8	
3	Cow dung + Seri-waste + Rice straw (T-3)	a) Mites	4	18
		b) Weevil	6	
		c) Ants	8	

III. Impact of vermicompost on soil and mulberry plant health.

a) Effect of different vermicompost treatment (T-1, T-2 and T-3) on germination percentage:

For calculating germination percentage or effective rate of seed germination sowed under different soil treated with different combinations of vermicompost the seeds were soaked in different vermin-wash solutions for 7 days and observed under electron microscope for the development of plumule and radical (Fig. 03).The seeds under different vermin-wash treatment exhibited germination percentage for the

mulberry seeds treated with Cow dung + Seri-waste (T-2) exhibiting 90% germination rate followed by T-3 and T-1 as 88% and 84% respectively. Thus, indicated the suitability of vermicompost derived from seri-waste to recover maximum germination percentage (Table-05). Similar, experiment was carried out by Sinha *et al.,* [28] who reported the maximum germination percentage of 94%for the seeds treated with vermiwash solution derived from sericultural waste and Karmegam and Daniel [29], Kala *et al.,* [30] who reported the increased germination percentage of 98% for the seeds soaked with vermiwash solution. Similar, experiment was conducted by Atik and Yilmaz [31] indicated the improved morphological and physiological properties of the seedling provided with vermiwash application hence, validated the current results.

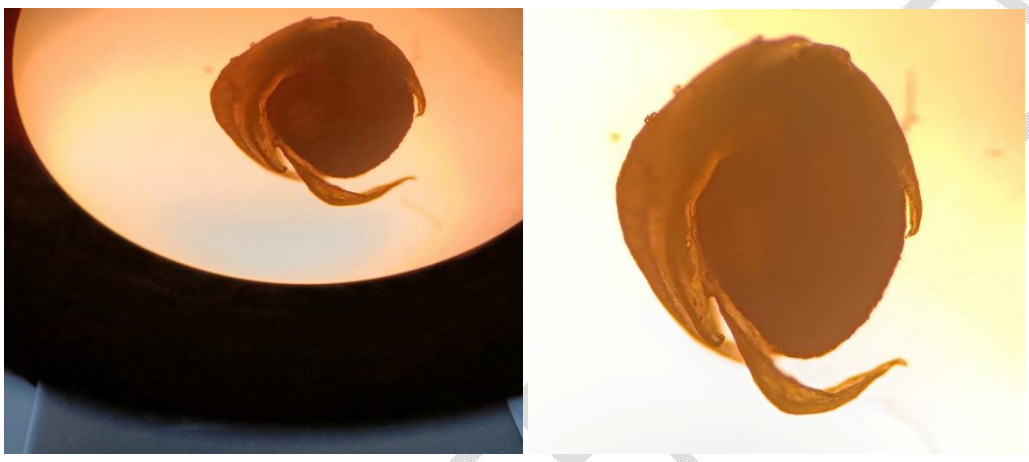

Fig.-03: Germination test under electron microscope for development of radical

b) Root and shoot length

The seedlings growing in the soil treated with different samples of vermicompost was evaluated for shoot and root length. Values for root and shoot length was recorded to be highest in case of T-2 (Cow dung +Seri-waste) and T-3 (Cow dung +Seri-waste+ Rice straw) as 26cm and 24cm respectively indicating the superiority of Cow dung and Seri-waste (T-2) combination (Table-05). Livia *et al.,* [32] recorded the similarly observation with respect to length of primary root and shoot for the mulberry plants treated with vermicompost.

c) Moisture percentage and MRC of leaf:

Mulberry plants growing in soil treated with different samples of vermicompost was analyzed for moisture and MRC percentage (Fig. 04).The moisture percentage of leaf is calculated with the help of formula:

$$\frac{\text{Fresh weight (FW)} - \text{Dry weight (DW)} \times 100}{\text{Fresh weigh (FW)}}$$

Significantly higher values for fresh and dry weight, moisture percentage and MRC was recorded to be highest for T-2(Cow dung +Seri-waste) with 7.1g and 1.8g (fresh and dry weight) 74.64 and 73.21% respectively (Table-05). Application of aqueous extract of vermicompost was recorded to improve the mulberry plant health, crop yield and nutrients quality as reported by Gamaley *et al.,* [33]. In the addition, Levinsh, G. [34] reported the positive effect of vermicompost on growth of bean and pea seedlings. Thus, confirming the observation of current experiment pertaining recommendation of Cow dung + Seri-waste (T-2) as best substrate for vermicompost.

Table-05: Effect of Cow dung + Rice straw (T-1), Cow dung + Seri-waste (T-2) and Cow dung + Seri-waste + Rice straw (T-3) on agronomic traits of mulberry

S. no	Treatment	Germination (%)	Root length (cm)	Shoot length (cm)	Fresh weight of leaf (mg)	Dry weight of leaf (mg)	Moisture percentage (%)	Moisture retention capacity (%)
1	T-1	88	19	8	10.1	2.4	76.23	61.39
2	T-2	90	26	12	7.1	1.8	74.64	73.21

3	T-3	84	34	10	7.2	3.3	54.16	66.67
MEAN		**87.33**	**10.00**	**8.133**	**2.50**	**68.34**	**67.09**	**67.09**
S.D		**3.055**	**2.000**	**1.703**	**0.754**	**12.30**	**5.921**	**7.505**
S.E		**1.763**	**1.154**	**0.983**	**0.435**	**7.106**	**3.418**	**4.333**

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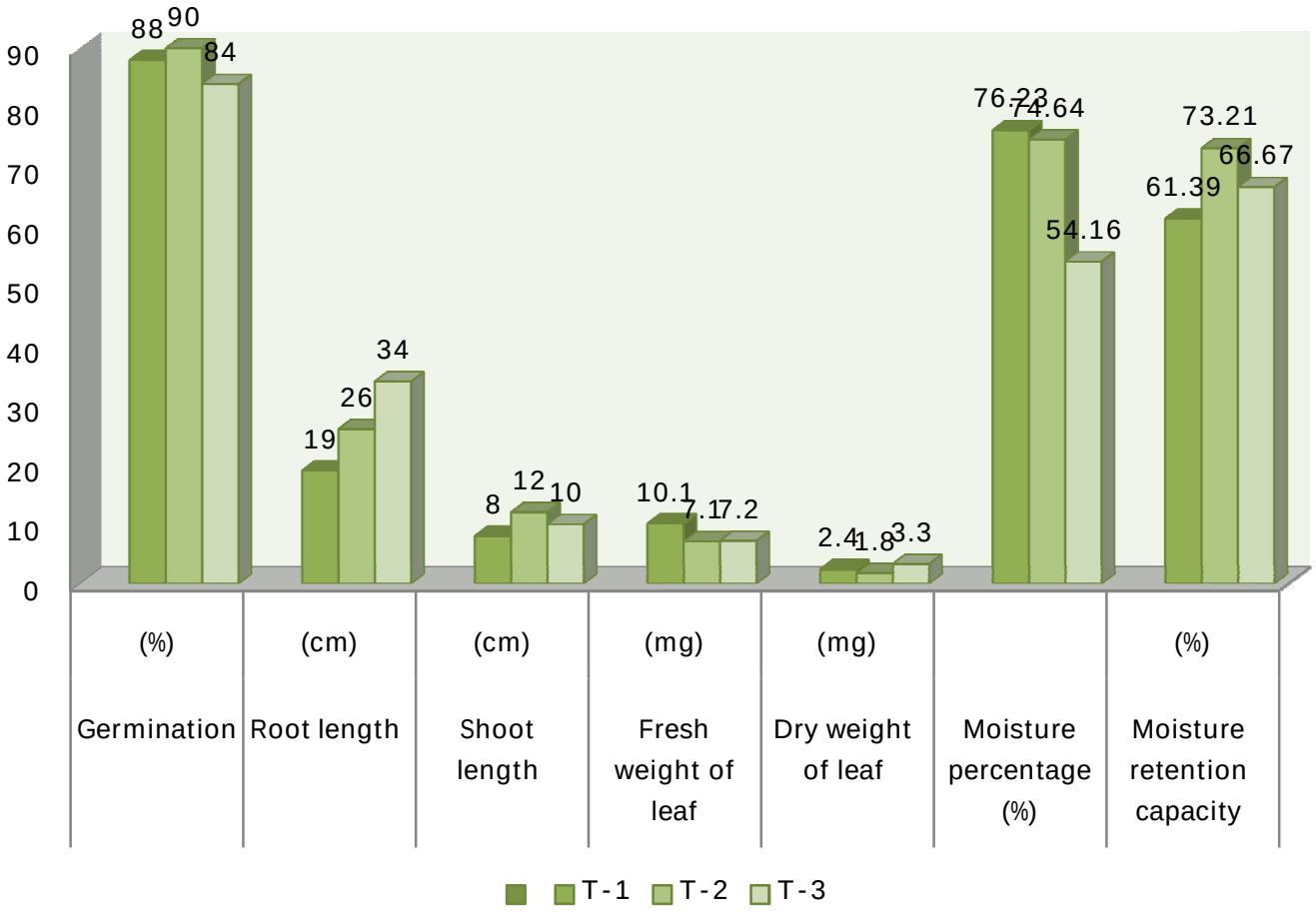

Fig.-04: Effect of Cow dung + Rice straw (T-1), Cow dung + Seri-waste (T-2) and Crowding + Seri-waste + Rice straw (T-3) on agronomic traits of mulberry.

Fig.-05: Vermicompost sample of T-1 (Cow dung + Rice straw)

Fig.-06: Vermicompost sample of T-2 (Cow dung + Seri-waste).

Fig.-07: Vermicompost sample of T-3 (Cow dung + Seri-waste + Rice straw).

CONCLUSIONS

Vermicompost is the end-product of breakdown of organic matter by some species of earthworm, resulting in the formation of nutrients rich organic fertilizer with soil conditioning properties. On the other hand, sericulture being agro-based industry involves generation of large number of organic wastes and by-products at each and every steps ranging from mulberry cultivation to silkworm rearing and reeling etc. Thus, the waste generated from mulberry cultivation and rearing wastes including silkworm litter, bed residues and other materials could be utilized for formation of nutrients rich vermicompost for accelerating the growth and quality of mulberry leaf. Keeping in view the significance of vermicompost, the current experiment was performed and the results obtained on nutrient profile, chemical nature, soil health status, microbial growth and agronomic traits of treated plants were found to be superior in case of the product generated from Cow dung +Seri-waste (T-2) substrate. Hence, it can be concluded that (T-2) Cow dung +Seri-waste form most suitable combination of mulberry plant growth and yield.The current experiment opens new avenues for promoting by-product utilization seri-waste in sericulture. The resultant product could be utilized for agricultural and horticultural as well.

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