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Influence of different manures on the Germination and Seedling growth of Mulberry (*Morus* sp.)

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Abstract
The investigation was carried out at Temperate Sericulture Research Institute (TSRI) Mirgund, SKUAST- K, in the year 2015. Amongst various manures (FYM, Dalweed, vermicompost, poultrymanur, silkworm litter) tested T_2 (Dalweed) seemed to be the best manure influencing the various parameters of mulberry seedlings right from the germination upto growth of seedlings. By popularizing this manure, the pressure on other manures especially FYM can be reduced to great extent besides providing the stakeholders different options of manure. This will also help in proper disposal of wastes got from different agricultural activities and other water bodies in most eco-friendly and economically viable manner. Therefore, in this article we explore the effect of different manure treatments on the germination success and development of seedlings of the mulberry crop.

Keywords: *Dalweed, Germination, Manure, Mulberry, Seedling*

Introduction
Plants need a well-balanced nutrition for better growth and yield. Manures are the substances which provide nutrients for proper growth of plants. Manure is anything organic that has been added to the soil to increase its fertility and enhances plant growth. The application of manures to soil provides potential benefits including improving the fertility, structure, water holding capacity of soil, increasing soil organic matter thereby reducing the amount of synthetic fertilizer needed for crop production (Blay *et al.,* 2002) [4]. Manure in the form of decomposed cow dung has been used with success. The availability of this manure is not in tune with requirement because it is extensively used for other agricultural and horticultural crops and as a fuel in rural areas. On the other hand, the wastes from other farm activities remain unutilized and get accumulated over time and thus demand for their proper dumping. These wastes include excreta from poultry, sheep manure, weeds from farms and water bodies and wastes such as silkworm litter from silkworm rearing. The efficient and scientific utilization of these wastes will not only reduce the problems accruing through their dumping but will also add manurial component to the soil making it more fertile and sustainable besides keeping the environment pollution free. Till now, least information is available on these aspects in the Kashmir region, since the mulberry is a commercial crop in the valley as for as sericulture industry is concerned.

Material and methods
Different manures were added to the garden soil @ 100 g manure per two kilograms of medium except poultry manure which was added @ 50 g per two kg of medium before sowing. This is because poultry manure when applied in high dose affects the germination of seeds as it becomes injurious to the seeds and kills the embryos before emergence (Sekar, 2010) [25]. Poultry manure also contains high percentage of nitrogen which has burning effect (Ikpe and Powel, 2002) [17]. Twenty-eight seeds of mulberry (*Morus* sp.) were sown (Peaslee, 2002) [22] with approximately equal spacing between the seeds at uniform depth of 0.5-1 cm in each treatment. The experiment was laid in CRD (Completely randomized design) with four replications and six treatments (T1=FYM @100 g, T2=Dalweed@100 g, T3=Vermicompost @100 g, T4=Poultry manure @ 50 g, T5=Silkwormlitter @ 100g, T6=Control, without manure). The bags were watered regularly twice (morning and evening) and kept in sunlight. Some dried weeds were used as mulches to preserve moisture and protect the bags from rains. Observations were recorded on the following parameters

Germination percentage
Germination started after 11 days of sowing the seeds. From 11^{th} day observations were taken regularly and germinated seeds were counted daily to calculate germination percentage as per the International Seed Testing Association (ISTA) procedure (Anonymous, 1985) [3]. It was calculated as per the following formula given below:

$$\text{Germination percentage} = \frac{\text{No. of seeds germinated}}{\text{No. of seeds sown}} \times 100$$

Germination rate
It was calculated by the formula suggested by Ellis and Roberts (1980).
$R= \sum n/\sum Dn$
Where, R is the germination rate, n is the number of seeds germinated in days and D is the number of days counted from the beginning of the test.

No. of roots per seedling
Seedlings were uprooted, washed thoroughly to remove the adhering soil and the roots counted manually. Five seedlings were taken in each treatment to calculate the average value of roots per seedling.

Length of longest root (cm)
The length of longest root was measured by using normal scale in centimeter from its base to the tip. Five seedlings were taken in each treatment to calculate the average root length.

Root weight (g)
The whole root was cut off from the seedling at the point of its origin and dried between the folds of a blotting paper. The weight of root portion of the seedling was finally recorded by using a digital balance. Five seedlings were taken in each treatment to calculate the average value.

Shoot weight (g)
The shoot left after cutting the root portion of the seedlings was weighed one by one for five seedlings by using digital balance in each treatment to calculate the average shoot weight.

Root volume (cc)
The root mass after its drying in the blotting paper was used for root volume estimation using a graduated glass cylinder by water displacement technique. Whole root mass was dipped completely in the water present in cylinder and the rise in water level was used to calculate root volume. Five observations were taken to calculate the average root volume.

Thickness of seedling (cm)
This was done by using Vernier Caliper. Three readings of each seedling were taken at three different places viz. bottom, middle and top portion and then average thickness per seedling was calculated. From every treatment five observations were taken to calculate the average thickness of seedling.

Height of seedlings (cm)
The height (cm) of seedling was measured by using normal scale in centimeter from base to the tip of the seedlings. Five observations were taken to calculate the average height of seedling.

No. of leaves per seedling
The leaves of seedlings were counted manually. Five observations were taken to calculate the average number of leaves.

Root-shoot ratio
The root-shoot ratios were calculated by using the following formula:

$$\text{Root-shoot ratio} = \frac{\text{Weight of the root}}{\text{Weight of shoot}}$$

Five seedlings were taken in each treatment to calculate the average value of root -shoot ratio.

Seedling vigour index (SVI)
It was computed by the formula suggested Abul-Baki and Anderson (1973) as:
SVI= Germination (%) × Seedling length (cm)
For all the parameters except germination percentage and germination rate, five seedlings per treatment per replication were taken to calculate the average value. The day sowing was taken as the first day and the total number of seeds germinated on each day was counted and recorded.

Statistical analysis
The data collected was compiled and analyzed statistically using a method described by Gomez and Gomez (1984). The significance of 'F' & 't' was tested at 5 per cent level of significance. Software package used for analysis was "OPstat" Whenever the F test was found significant at 5 per cent probability; critical difference values were used to compare the treatment means.

Results and Discussion
Germination rate was maximum (0.088) in T_2 (Dalweed), which was statistically at par with 0.083 recorded in T_1 (FYM) and significantly higher than rest of the treatments. It was least (0.061) in T_6 (control). Germination percentage too was maximum (86.60%) in T_2 (Dalweed) being at par with (82.90) with T_1 (FYM) and significantly higher than rest of the treatments. The least value for germination percentage (58.90%) was found in T_6 (control). Results indicated that the type of manure in the medium used for seedling raising in mulberry had a great effect on the germination of seeds and the consequent growth and development of mulberry seedlings. Germination rate was significantly higher in T_2 (Dalweed), T_4 (Poultry manure) and T_1 (FYM) than rest of the treatments. Germination percentage was maximum in T_2 (Dalweed) than rest of the treatments being the least in T_6 where no manure was used. The manures in general improved the germination and other growth parameters which might be due to favorable soil physical environment created by the addition of organic manures (Sarma and Gogoi, 2015) [24]. The superiority of Dalweed over the rest of the manures is due to presence of brassinosteroids which are involved in production of enzymes, increased nucleic acid content and soluble proteins and lowering the activities of RNAase enzyme which is necessary for seed germination. Mahesh *et al*. (2013) [19], reported that brassinosteroids increased germination rate and percentage in radish seeds by elevating levels of nucleic acids and soluble proteins and lowering the activities of RNase enzyme. Another possible reason might be easy rupturing of the endosperm and enhancement in growth potential of the embryo by brassinosteroids.

Table 1: Influence of different manures on seed germination parameters in mulberry.

Treatment	Total number of seeds germinated	Number of days for seed germination	Germination rate	Germination percentage
T_1 @ 100g	23.22^b	12.00^a	0.083^a	82.90^b
T_2 @ 100g	24.25^a	11.25^a	0.088^a	86.60^a
T_3 @ 100g	22.50^b	14.75^c	0.068^c	80.30^c
T_4 @ 50g	23.40^a	12.50^a	0.080^b	83.50^b
T_5 @ 100g	22.90^b	14.25^b	0.070^c	81.79^b
T_6 (C)	16.50^c	16.25^d	0.061^d	58.90^d
C.D ($p \leq 0.05$)	0.85	1.38	0.006	3.00
SEm±	0.28	0.46	0.002	1.00
C.V.%	2.69	5.54	5.695	2.68

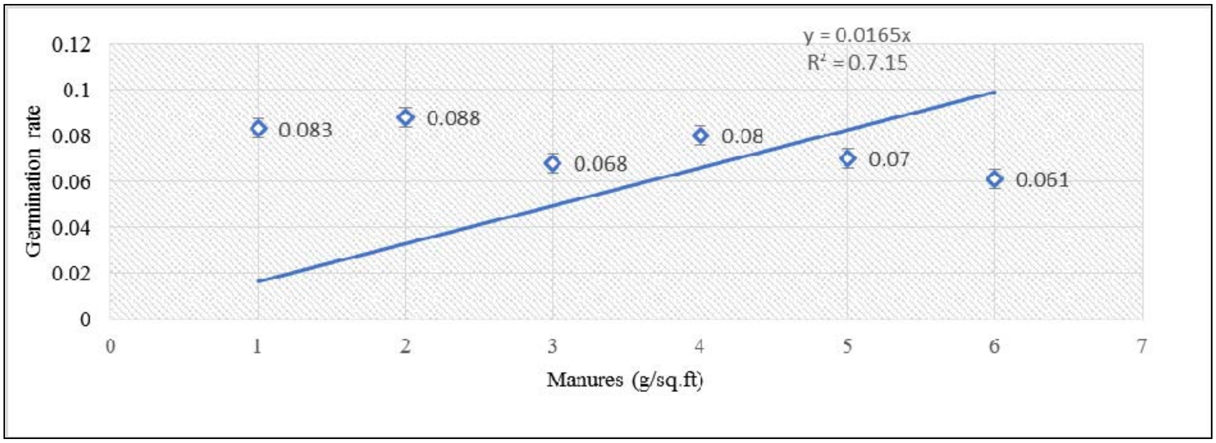

Fig 1: Germination rate as influenced by different manures

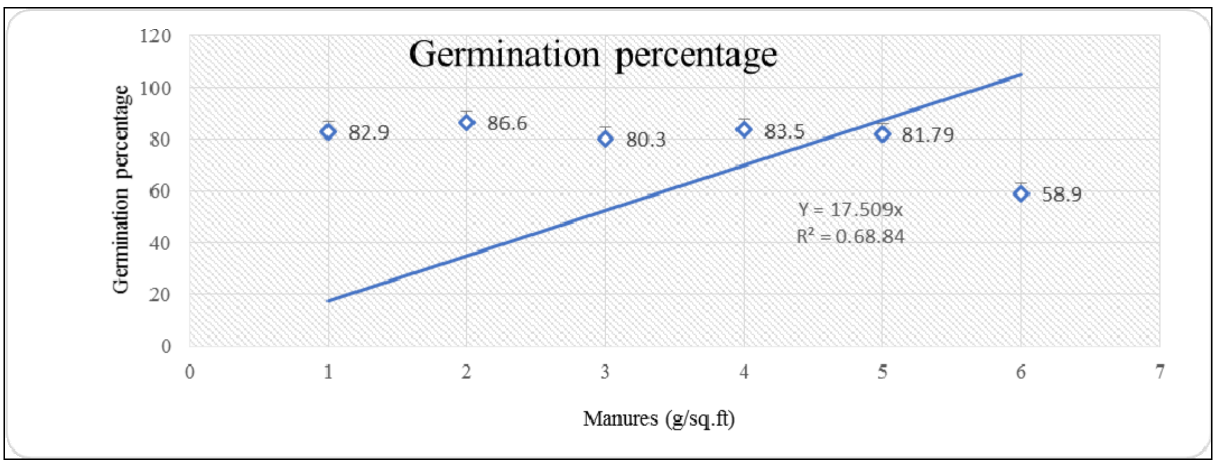

Fig 2: Germination percentage as influenced by different manures

Shoot parameters of mulberry seedlings

Seedling height was maximum (17.50 cm) inT_2 (Dalweed) which was significantly higher than rest of the treatments. It was however least in T_6 (control) recording a seedling height of 7.35 centimeters. The highest number of leaves per seedling (12.30) was recorded in T_2 (Dalweed) which was significantly higher than rest of the treatments. The least number (6.40) of leaves per seedling was again recorded in T_6 (control). The mean thickness of seedling was found to be the highest (0.40 cm) in T_2 (Dalweed) which was significantly higher than rest of the treatments T_1, T_3, T_4, T_5 and T_6 (control). The least value (0.25 mm) for thickness of seedling was recorded in T_6 (control). Dry shoot weight too was maximum (1.85 g) in T_2 (Dalweed) which was significantly higher than T_1, T_3, T_4, T_5 and T_6 (control). The least value (0.48 g) of shoot weight was recorded in T_6 (control). Seedling vigour index was maximum (1515.50) inT_2 (Dalweed) which was significantly higher than T_1, T_3, T_4, T_5 and T_6 (control). The least value (432.92) for seedling vigour index was recorded in T_6 (control). The shoot parameters of mulberry seedlings were better using organic manures than those raised without any manure. Hedge (1997) [16] reported that organic manure such as FYM, sheep manure, poultry manure and compost are known to have beneficial effects on soil health. Similarly, Das *et al.* (1997) [9] reported feasibility of conversion of sericultural waste into nutrient rich manure as potential manure for mulberry cultivation. Gupta *et al.* (2005) [15] reported that the use of organic manures improves soil health, soil ecology and soil environment supplying essential micronutrients, improve soil physical and chemical properties and build soil micro flora which is involved in nitrogen fixation and recycling pathways of other minerals. The superiority of Dalweed in improving the shoot parameters of mulberry seedlings (seedling height, number of leaves per seedling, thickness of seedling, dry shoot weight and seedling vigour index) over other manures used could be because of the reasons that Dalweed induces vigorous and fast growth in seedlings due to better water holding capacity and availability of nutrients than other manures. Mugloo *et al*. (2010) [21], reported more availability of nutrients and moisture in Dalweed which are the basic requirements for proper establishment and faster plant growth. Dalweed may have increased supply of nutrients at the younger stages of seedling growth which in mulberry seedlings result in increased number of leaves per seedling and hence more photosynthates are synthesized in the leaves which leads to increased thickness and dry shoot of the seedlings. These lines are in cofirmity with the findings of Colapietra and Alexander (2006) [8], who reported that decomposed aquatic weed makes plants healthier by producing more leaves in grapes, Gallen and Hemingway (1965) [14] and Sivasankari *et al*. (2006) [28] in peanut, Raiz *et al*. (2008) [23] in tomato, Balasubramanian and Palaniapan (2004) in groundnut, Kayum *et al*. (2008) [18] in tomato and Amitava *et al*. (2008) [2] in rice. Dalweed provides favorable medium for shoot growth and germination of seeds and enhances the survival percentage of seedlings than other manures. The results were in accordance with the findings of Demir *et al*. (2006) [10, 11], who reported that weed in decomposed form improve seedling emergence, germination percentage and rate and seedling vigour index in many crops. Similar findings have been reported by Boopathy and Balasubramanian (2004) [6] in sunflower, Gaffer *et al*. (1992) [13] in sorghum and Maleswar *et al*. (2000) in sunflower. Dalweed also provides a favorable environment to different microorganisms that might have increased the vigour index by their different activities. Shaukat *et al*. (2006) [26], reported that Azospirillum, Pseudomonas and Azotobacter strains present in Dalweed increase seed germination and seedling growth in sunflower.

Table 2: Influence of different manures on shoot parameters of mulberry seedlings.

Treatment	Seedling height (cm)	Number of leaves per seedling	Mean thickness of seedling(cm)	Dry shoot weight(g)	Seedling vigour index
T_1 @ 100g	15.21^e	10.02^b	0.30^c	1.75^c	1260.91^e
T_2 @ 100g	17.50^a	12.30^a	0.40^a	1.85^a	1515.50^a
T_3 @ 100g	16.25^c	10.20^b	0.32^b	1.80^b	1304.88^c
T_4 @ 50g	16.90^b	11.69^a	0.35^b	1.80^b	1411.15^b
T_5 @ 100g	15.75^d	10.40^b	0.33^b	1.83^a	1288.19^d
T_6 (C)	7.35^f	6.40^c	0.25^d	0.48^d	432.92^f
C.D ($p\leq0.05$)	0.21	0.61	0.04	0.020	16.98
SEm±	0.07	0.20	0.01	0.007	5.66
C.V.%	1.04	5.55	6.43	1.10	1.31

Root parameters of mulberry seedlings

The length of longest root was maximum (16.97cm) in T_2 (Dalweed) which was statistically different from rest of the treatments. The minimum value (9.70 cm) for longest root length was recorded in T_6 (control). The average number of roots per seedlings was found to be maximum (12.10) in T_2 (Dalweed) which was statistically different from rest of the treatments. The minimum number of roots per seedling (4.70) was recorded in T_6 (control). The maximum root volume (2.06 cc) was recorded in T_2 (Dalweed) which was significantly higher than the rest of the treatments in which it ranged from 0.51 cc in T_6 (control) to1.95 cc in T_4 (poultry manure). The dry root weight was the highest (1.90 g) in T_2 (Dalweed) being statistically higher than rest of the treatments. The least value (0.30 g) for root weight was again recorded in T_6 (control). The highest root shoot ratio of 1.02 was recorded in T_2 (Dalweed) which was statistically higher than the values recorded in rest of the treatments. The lowest value (0.63) for root shoot ratio was recorded in T_6 (control). The superiority of Dalweed in root parameters (length of longest root, number of roots per seedling, dry root weight and root shoot ratio) over other manures used could be because it increases the activity of meristematic cells and their divisions due to high organic matter and micronutrients present in it. The porosity of Dalweed helps in easy penetration of the root, resulted in higher root length, number of roots, dry root weight, root volume and root shoot ratio of the seedlings. The results are in conformity with the findings of Bradacova (2016) [7] and Vidya and Girish (2014) [29], who reported a positive effect of Dalweed on plant growth particularly on root development in maize. Dalweed appears to be the most suitable manure owing to its influence on improvement of germination of mulberry seeds and the overall growth and development of seedlings. The results are in accordance with Demir *et al*. (2006) [10, 11]. The superiority of Dalweed to other manures can be attributed to the fact that it improves the soil texture and is a rich source of various nutrients. Zahoor and Nazir (2015) [30] reported a good concentration of total lipids, carbohydrates and total protein in Dal weed and suggested its use as a potential source of nutrients for many crops. Singh and Sharma (2009) [27] reported that Dal weed (*Myrophillum spicatum* and *Serophyllum demersum*) available in plenty in the world-famous Dal lake of Kashmir a rich source of N, P and K and can be used to soil fertility and the powdered Dalweed could also be used as a manure for seed germination. Advocating the use of this manure on large scale for agriculture could address the multiple problems of cleaning of Dal lake, disposal of the weeds and reducing the pressure on other locally available manures which face pressure from most of the crops grown in the region

Table 3: Influence of different manures on root parameters of mulberry seedlings.

Treatment	Longest root length (cm)	Number of roots per seedling	Root volume (ml)	Dry root weight (g)	Root-Shoot ratio
T_1 @ 100g	15.30^c	10.10^c	1.80^c	1.50^c	0.85^c
T_2 @ 100g	16.97^a	12.10^a	2.06^a	1.90^a	1.02^a
T_3 @ 100g	16.20^b	11.91^a	1.92^b	1.64^b	0.91^b
T_4 @ 50g	16.73^a	11.94^a	1.95^b	1.76^b	0.98^a

T_5 @ 100g	16.72[a]	10.30[b]	1.90[b]	1.63[b]	0.89[b]
T_6 (C)	9.70[d]	4.70[d]	0.51[d]	0.30[d]	0.63[d]
C.D ($p \leq 0.05$)	0.25	0.58	0.09	0.014	0.05
SEm±	0.08	0.19	0.03	0.005	0.02
C.V.%	1.33	5.19	3.72	1.20	4.06

Summary and Conclusion

The study proved effectiveness of Dalweed in raising the mulberry seedlings as against farmyard manure and poultry manure. Using Dalweed which is found in abundance in the different lakes of Kashmir would reduce the dependence of Sericulturists on farmyard and poultry manure and would as such reduce pressure on these manures. Besides Dalweed is easily available manure and hence if its use is popularized it will not only make mulberry cultivation profitable but will also address the problem of cleaning of the water bodies and disposal of the weeds in an effective and proper way.

Conflict of interest

There is no conflict of interest among the authors.

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