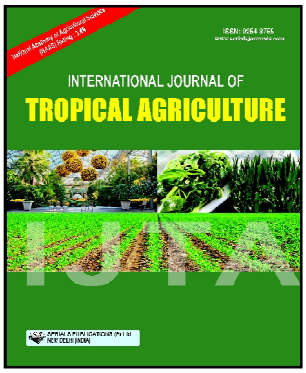

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Field Impact of Different Manuring Practices on Yield and Quality of Mulberry leaf and Rearing Parameters of Silkworm, *Bombyx mori* L.

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Abstract: Studies were conducted to find out the impact of different manuring practices in mulberry garden on leaf yield and quality and its influence on rearing parameters of silkworm (Bombyx mori L.). Among the different manuring practices, significantly maximum leaf yield, highest content of foliar nutrients (moisture, N, P, K, total protein and total carbohydrate) and superior values in economic traits of silkworm were recorded with the mulberry gardens invariably received different organic inputs viz. Azospirillum & Phosphobacteria formulation @ 2 kg/crop, FYM @ 8-10 MT / ha/year in two split doses and one time mulching of green manure dhaincha (Sesbania aculeata) and other organic inputs like poultry manure, pressmud etc than the application of recommended doses of chemical fertilizers alone. The organic manuring practices with application of 25% of recommended doses of chemical fertilizers and foliar fertigation with "Poshan" an exclusive foliar formulation for mulberry exhibited on par results with sole organic farming practices. Thus a holistic approach should be made for creating awareness among the sericulture farmers and popularizing organic farming strategies for sustainable production of cocoon and to fetch more profit through sericulture.

Keywords: manures, mulberry leaf yield, quality, silkworms, economic traits

INTRODUCTION

India is home for a vast variety of wild silk moths having an amazing diversity in nature. This has enabled the country to acquire an unparallel distinction of being only producer of all five commercially traded varieties of natural silks

commonly known based on host plants namely mulberry (*Morus* spp.), tropical tasar and oak tasar (*Terminalia* spp.), eri (*Ricinus* spp. and others) and muga (*Litsea* spp.). But owing to their contribution to silk production in the country they are grouped in two categories, *viz.* mulberry silk which contribute to about 90% of the total silk and rest of them are collectively termed as non-mulberry or Vanya (wild) silks. India is the second largest producer of silk in the world and biggest consumer of raw silk. Sericulture is an agro based industry and have steady growth year by year as it plays vital role in self employment, women empowerment and livelihood security in rural sectors. Sericulture is practiced in about 59,000 villages involving six million families in the country.

Mulberry sericulture is mainly practiced in five states namely, Karnataka, Tamil Nadu, Andhra Pradesh, West Bengal, and Jammu and Kashmir. Mulberry (*Morus alba* L.), the food plant of silkworm (*Bombyx mori* L.) is perennial in nature and once cultivated, used continuously for about 20-30 years for silk production. Under tropical conditions, the plants are pruned 5-6 times annually to take up silkworm rearing and routine application of fertilizers after each harvest is an integral part of moriculture to ensure production of quality leaves for healthy growth of silkworms as well as to optimize the cocoon yield and silk quality. However, long-term application of chemical fertilizers in bimonthly interval in mulberry garden is not only pollute the ecosystem but also cause adverse impact on soil health. This reflects adversely on mulberry growth and yield parameters and the farmers face depletion in cocoon yield. In recent past organic farming in mulberry cultivation is drawing greater attention for sustainable production of silk and the farmers showing keen interest to supplement organic inputs. A study was thus carried out to find out the impact of different manuring practices adopted by the sericulture farmers on mulberry leaf quality and yield and its impact on cocoon production.

MATERIALS AND METHODS

The studies were conducted in the potential sericulture clusters in Virudhunagar district of Tamil Nadu, India. Survey was conducted with the farmers who practicing sericulture for more than three years using a questionnaire and obtained information on fertilizer type and usage history in their mulberry garden. Based on the survey, the farmers were categorized in to eight groups as detailed below.

T_1: Farmers applying recommended doses of chemical fertilizers NPK @ 28:11:11 kg per crop and FYM @ 8-10 MT / ha/year [3].

T_2: T_1 + foliar application of Poshan (A foliar nutrient formulation for mulberry).

T_3: 50% reduced application of recommended doses of N & P, *Azospirillum* & Phosphobacteria formulation @ 2 kg each / crop and FYM @ 8-10 MT / ha/year.

T_4: T_3 + foliar application of Poshan

T_5: 75% reduced application of recommended doses of N & P, *Azospirillum* & Phosphobacteria formulation @ 2 kg each / crop, FYM @ 8-10 MT / ha/year and annual green manuring with dhaincha (*Sesbania aculeata).*

T_6: T_5 + foliar application of Poshan

T_7: Invariably apply different organic inputs (100% organic) *viz.* Azospirillum & Phosphobacteria formulation @ 2 kg/crop, FYM @ 8-10 MT / ha/year and one time mulching of green manure dhaincha (*Sesbania aculeata)* and other organic inputs like poultry manure, pressmud *etc.*

T_8: Farmers using only chemical fertilizers below the level of recommended doses (control).

Three farmers from each group (treatment) cultivated V1 mulberry variety were selected for the study. Mulberry growth and leaf yield parameters *viz.* Plant height (cm), Leaf yield/ plant(g), Leaf yield (MT/ha/year) and Silkworm rearing capacity (Dfls

/ ha) were recorded from 15 randomly selected plants per garden 60 days after each pruning and 1 kg of composite leaf samples per treatment were processed to estimate the foliar constituents. Moisture percentage and moisture retaining capacity was estimated as defined by [4]. The biochemical contents *viz.* nitrogen (N), phosphorous (P) and potash (K) [8], Protein [11], carbohydrate [7] were determined using standard procedures.

In order to find out the effect of manuring practices on rearing parameters of silkworm, all the farmers were uniformly supplied with the commercial double hybrid FC1 x FC2 silkworms after second moult and allowed to rear further as per the recommended package of practices [3] till cocooning and entire rearing were monitored by periodical visits. Data on larval periods (days), matured larval weight (g), survivability (%), single cocoon weight (g), single shell weight (g), silk ratio (%), average cocoon yield (kg/100 dfls), average cocoon productivity (kg/ha of mulberry garden) were recorded at each rearing. The studies were repeated consecutively for three years during 2013-2015 covering 3-5 crops per year based on the availability of irrigation water source with the farmers. All the data were analyzed statistically [23].

RESULTS AND DISCUSSION

The data on the growth and yield parameters of mulberry as influenced by different manuring practices showed notable variations in plant height, leaf yield, leaf yield and rearing capacity of silkworm (Table 1). Among the different manuring practices, significantly maximum height of plants (213.16 cm), leaf yield per plant (917.60 g), leaf yield per hectare (50.46 MT) and rearing capacity of silkworm (3364 dfls) were recorded in T6 on application of different organic inputs and only 25% of recommended doses of chemical fertilizers and it was followed closely by 100 % organic farming system (T7) with respective values of 195.68cm, 895.23 g, 49.23 MT and 3282 dfls. Least values on plant height (153.25 cm), leaf yield per plant (688.27 g), leaf yield per hectare (37.85 MT) and rearing capacity of silkworm (2523 dfls) was recorded with the control *i.e.* the gardens received only chemical inputs below the level of recommended doses (T8). However, all the gardens sprayed with Poshan (T2, T4 and T6) showed slight improvement in all parameters than the respective treatments of unsprayed gardens (T1, T3 & T5).

The increased leaf yield in T6 and T7 may be due to the fact that application of various organic inputs *viz.* FYM, bio-fertilizers (Azospirillum & Phosphobacteria) annual green manuring with dhaincha (*Sesbania aculeata)* and annually one time mulching of green manures might have helped in slow and steady release of nutrients in addition to supply of important macro and micro-nutrients besides efficient supply of N and P by nitrogen fixing and phosphorus solubilizing bio-inoculants. However, T6 showed comparatively more values because of additional support of 25% of recommended doses of chemical fertilizers and foliar fertigation with Poshan for each crop. The results are in accordance with the early findings [16]. The lowest leaf yield on 100 per cent chemical fertilizers application may be due to less number of shoots and leaves per plant, shorter plant height and in turn these may be due to insufficient availability of nutrients in the root zone of mulberry plants to be absorbed by the roots due to leaching out of root zone or fixed into unavailable form due to high pH of soil. Similarly, [12] reported that, application of different kinds of organic manures and combination of organic manures + inorganic fertilizers recorded significantly higher number of shoots per plant, higher number of leaves and leaf yield per plant as compared to NPK alone through chemical fertilizers in mulberry. Farm yard manure and lowest level of NPK treated plants showed maximum leaf yield than 100 percent of recommended doses of chemical

fertilizers [20]. Introduction of crop benefiting microbial inoculants in to soil play a significant role in the mobilization of various nutrients needed by the crop and application of microbial inoculants in conjunction with organic manures has significantly increased the productivity of mulberry leaf [1]. The finding of present investigation is with conformity of earlier works.

In respect of leaf quality, leaf moisture, moisture retention capacity, N, P, K, total protein and total carbohydrate contents were found differed significantly in relation to varied manuring practices in mulberry garden (Table 2). The leaves harvested from the gardens applied purely with organic inputs (T7) was registered superior values of moisture content (72.33%), moisture retention capacity (82.13%), N (3.78%), P (0.39%), K (1.72%), protein content (23.33%) and carbohydrate content (30.23%) followed by T6 (68.58%, 82.68%, 3.29%, 0.42%, 1.66%, 21.00% & 30.75%) where as the gardens received repeated doses of chemical fertilizers (T8) exhibited least values viz. 55.70%, 60.25%, 2.11%, 0.33%, 0.49%, 16.07% & 23.30% of respective parameters.

Overall performance of all the manuring practices showed that organic fertilization had a positive effect on yield and quality of mulberry. Similar positive relationship with organic inputs and mulberry leaf quality was reported by [2, 22 &15]. In mulberry, leaf moisture content (LMC) and moisture retention capacity (MRC) are the two important factors that maintain the nutritive levels of leaves, which in turn improves the palatability of leaves for silkworm. This could be attributed to more moisture content in organic garden and increased fertile value of the soil. In the present study, increase in dosages of chemical fertilizers resulted to decrease in leaf quality which could be attributed to the deleterious effect of repeated applications of chemicals on physical and biological properties of soil. The beneficial effect of organic resources resulted in sustainable improvement in growth attributes, leaf yield and quality due to proper decomposition, mineralization, solubilizing effects and availability of sufficient nutrients as observed in T7 and T6.This corroborates the findings [6, 18 &21] in mulberry particularly in relation to the use of two types of biofertilizers, vermicompost and integrated nutrient management packages.

Varied manuring practices in mulberry garden significantly influenced the rearing parameters of silkworm and cocoon yield except that of larval period (Table 3). Feeding silkworms with the leaves harvested from the gardens applied purely with organic inputs (T7) and organic inputs with 25% of recommended dose of chemical fertilizers (T6) exhibited on par values and superior in economic traits of silkworms *viz.* weight of matured larvae (4.67 & 4.65g), survivability (79.23 & 78.59 %), single cocoon weight (1.871 & 1.840 g), single shell weight (0.440 & 0.429 g), silk ratio (23.51 & 23.14 %), average cocoon yield (80.610 & 81.038 kg / 100 dfls) and average cocoon productivity (2695 & 2726 kg per hectare of mulberry garden) when compared to control (T8) which yielded least values in respective economic traits (3.16g, 46.72%, 1.653g, 0.328g, 19.84%, 57.216 kg/100 dfls & 1443 kg/ha). These results are agreement with those of [19 &14] who observed that use of organic fertilizers or combined application of composted sericulture wastes along with fertilizers, registered highest silk productivity. Increase in these parameters were influenced by different sources of organic manures and inorganic fertilizers which were applied to mulberry might have increased the crude protein content in leaves which in turn influenced the silk productivity and cocoon yield.

The results on the influence of varied sources of organics on mulberry and its influence on the performance of silkworm are discussed in the light of earlier works. The economic traits of silk worm

and cocoon yield were differed considerably when worms fed on mulberry grown by the application of varied sources of organic manures and the foliar constituents of mulberry showed marked positive influence on rearing parameters. It is reported that the feeding silkworms with leaf obtained by application of 50% N through FYM and 50% N through urea recorded higher cocoon weight, shell weight and shell ratio in CSR-2 x CSR-4 silkworm breed[9]. As reported earlier [5] silkworm rearing using the leaf obtained by application of vermicompost revealed no significant difference in the larval weight while effective rate of rearing by number and by weight, cocoon weight, shell weight and shell percentage were significantly improved. The cocoons spun by the silkworms fed on mulberry obtained by supplying the crop with different sources of organic manures had notable influence on cocoon traits. The mulberry leaves of organic manures applied plots have more nutrient value than that of other treatments which in turn influences the silkworm cocoon quality [10].

The integrated nutrient management system is an alternative and is characterized by reducing the input of chemical fertilizers and combined use of chemical fertilizers with organic materials such as animal manures, crop residues, green manure and composts. Management systems that rely on organic inputs as plant nutrient sources have different dynamics of nutrient availability from those involving the use of chemical fertilizers. For sustainable crop production, integrated use of chemical and organic fertilizers has proved to be highly beneficial. Several researchers have demonstrated the beneficial effect of combined use of chemical and organic fertilizers to mitigate the deficiency of many secondary and micronutrients in fields that continuously received the only N, P and K fertilizers for a few years, without any micronutrient or organic fertilizer. Early studies [13 & 17] indicated that feeding of mulberry leaves obtained by application of FYM resulted in increased silk content and filament length. This further supports the present findings and confirms that organically produced mulberry leaves can supplement the nutritional requirement of silkworm by virtue of producing nutritionally balanced mulberry leaf. Studies) on integrated nutrient management (INM) in farmers' fields with various organic inputs confirmed the possibility of reducing recommended doses of NPK application by 25% after the first year and by 50% after the second year in mulberry cultivation. He found that organic inputs exhibited sustained improvement in chemical, physical and biological properties of soil [9].

In the present study, manuring practices with more organic inputs recorded higher leaf yield, quality and cocoon production than that of the chemical manuring practices. Number of workers reported integrated use of chemical and organic manures for maintaining soil health and increase the crop productivity. Though this concept was also emanated in this study, sole application of different organic inputs *viz.* FYM, vermicompost, pressmud, biofertilizers, green manuring, poultry manure, goat manure *etc* in mulberry garden was found superior than the chemical cum organic farming strategies. The organic farming systems are guided by the philosophy "feed the soil to feed the plant". Over time, adding organic materials to cultivated soils improves the level of soil organic matter. As soil organic matter increases, the ability of soil to supply nutrients to plant also increases. The ultimate goal is healthy, fertile biologically active soil with improved structure and enhanced nutrient availability. Thus it could be concluded that a holistic approach should be made for creating awareness among the sericulture farmers and popularizing organic farming strategies for sustainable production of cocoon and to fetch more profit through sericulture.

Table 1
Yield parameters of mulberry as influenced by different manuring practices

Treatments	*Plant height (cm)*	*Leaf yield/ plant (g)*	*Leaf yield (MT/ha/year)*	*Silkworm rearing capacity (Dfls / ha/yr)*	*% improvement over control*
T_1	162.87	783.63	43.10	2873	13.87
T_2	170.70	800.38	44.02	2934	16.29
T_3	175.06	795.87	43.77	2918	15.65
T_4	187.38	818.75	45.13	3008	19.22
T_5	186.55	863.18	47.47	3164	25.40
T_6	213.16	917.60	50.46	3364	33.33
T_7	195.68	895.23	49.23	3282	30.08
T_8	153.25	688.27	37.85	2523	—
CD @ 5%	12.58	33.31	6.35	218.13	—

Table 2
Quality of mulberry leaves as influenced by different manuring practices

Treatments	*Moisture content (%)*	*Moisture retention capacity (%)*	*N %*	*P %*	*K %*	*Total Protein (%)*	*Total carbo-hydrates (%)*
T_1	60.29	66.12	2.30	0.33	0.65	16.35	25.45
T_2	60.83	70.65	2.33	0.35	0.77	17.28	24.00
T_3	65.16	73.23	2.28	0.30	0.70	18.83	27.56
T_4	68.73	72.68	2.69	0.39	1.13	19.14	29.12
T_5	67.27	80.33	2.85	0.36	1.18	19.62	28.33
T_6	68.58	82.68	3.29	0.42	1.66	21.00	30.75
T_7	72.33	82.13	3.78	0.39	1.72	23.33	30.23
T_8	55.70	60.25	2.11	0.33	0.49	16.07	23.30
CD @ 5%	12.27	9.83	0.31	0.06	0.08	3.65	4.02

Table 3
Effect of different manuring practices on rearing performance of silkworm

Treat-ment	*Larval duration (Days) III-IV instars*	*Weight of matured larva(g)*	*Survival-bility (%)*	*Single cocoon weight (g)*	*Single shell weight (g)*	*Silk Ratio (%)*	*Average cocoon yield (kg/ 100 dfls)*	*Average cocoon productivity (kg/ ha of mulberry)*
T_1	17.09	3.23	53.31	1.659	0.343	20.67	63.739	1831
T_2	17.13	3.48	59.16	1.680	0.375	22.12	62.648	1838
T_3	17.20	3.40	60.33	1.749	0.388	22.18	70.553	2058
T_4	17.19	3.97	65.65	1.853	0.420	22.66	72.827	2190
T_5	17.17	4.40	67.94	1.845	0.427	23.73	75.279	2399
T_6	17.20	4.65	78.59	1.840	0.429	23.14	81.038	2726
T_7	17.13	4.67	79.23	1.871	0.440	23.51	80.610	2695
T_8	17.15	3.16	46.72	1.653	0.328	19.84	57.216	1443
CD @ 5%	—	0.18	3.47	0.07	0.03	2.25	12.66	188.37

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